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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

MINERAL RESOURCES

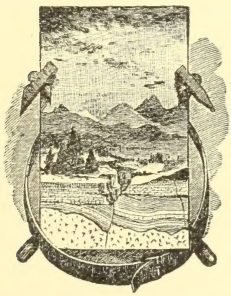
OF THE

UNITED STATES

CALENDAR YEAR

1908

PART I—METALLIC PRODUCTS



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MINERAL RESOURCES OF THE UNITED STATES FOR 1908—PART I.

INTRODUCTION.

CHARACTER AND SCOPE OF REPORT.

The arrangement and scope of this report are practically the same as in the twenty-four preceding reports of the series Mineral Resources of the United States. Each report records the development of the mineral industries of the United States since the time covered by the preceding number of the series; the reports should therefore be consulted together. Each chapter is a census of the productive features of the industry under discussion. The statistics of the imports and exports of minerals, which form an essential part of the volume, are obtained through the courtesy of the Chief of the Bureau of Statistics, Department of Commerce and Labor.

The summary gives the principal statistical information recorded in this report.

In presenting these statistics all unnecessary duplication has been avoided. The coke product, for example, discussed in the following pages and amounting in 1908 to 26,033,518 short tons, valued at $62,483,983, is excluded from the tabular statement, as the quantity and value of the coal used in its manufacture are included in the statistics of coal production. Similarly, white lead, red lead, litharge, and orange mineral, whose average aggregate value for the last ten years has exceeded $15,000,000, are not given in the table, the base from which they are made being included in the output of pig lead. Zinc oxide, zinc-lead, sublimed blue lead, and sublimed white lead, made directly from the ores, and consequently not included in spelter or lead production, are tabulated. The production of pig iron and its value are given in the table as the best means of presenting the statistics of the production of iron in the first marketable condition. The statistics of the production of iron ores are treated in a separate chapter, but are not included in the general statement of mineral products. The quantity and value of the production of iron ores are also shown in a footnote to the table of mineral products. In like manner the value of clay products is given as representing the first marketable condition of the clay resources of the country. Inflation of valuation and all unnecessary duplication are thus avoided as far as practicable.

In accordance with a change in the law (sundry civil appropriation act, approved May 27, 1908) governing the publication of this report, it will henceforth appear in two volumes, the first containing the statistics of the metallic products, and the second the statistics of the nonmetallic products of the country.

As heretofore, the publication of this report has been anticipated to a great extent by the issue in advance, in pamphlet form, of the several chapters which compose it.

ACKNOWLEDGMENTS.

Except as noted above, and in a few isolated instances where some other well-established agency already exists by which the statistics are collected accurately, the figures are obtained directly from the producers, and it is impossible to acknowledge here, otherwise than by brief mention, the invaluable assistance which has been freely rendered by them and by the voluntary contributions of many local experts. The technical press, besides affording much information concerning new mining enterprises, has been largely drawn upon for prices, market reports, and new technical processes.

The collection of the statistics of mineral production in 1908 has been conducted under cooperative agreements with a number of state geological surveys. The object to be attained in carrying out these cooperative agreements is threefold:

1. The avoidance of annoyance to the producers in the form of duplicate requests for statistical information.
2. The securing of prompter and more complete returns, and
3. The enabling of the state geologists to keep in touch with the producers and with new developments in their respective jurisdictions.

Special acknowledgment is made of the assistance received by the United States Geological Survey from the directors of the state surveys, while the cooperative arrangement has been carried out in a harmonious manner and with exceedingly gratifying results.

The state surveys which cooperated with the United States Geological Survey in 1908 are as follows:

Alabama	Dr. Eugene A. Smith, state geologist, University.
Georgia	Dr. S. W. McCallie, state geologist, Atlanta.
Illinois	Mr. Frank W. De Wolf, acting director, Urbana.
Iowa	Prof. S. W. Beyer, Iowa State College, Ames.
Kentucky	Prof. C. J. Norwood, director, Lexington.
Maryland	Dr. Wm. B. Clark, state geologist, Baltimore.
Missouri	Dr. H. A. Buehler, state geologist, Rolla.
New Jersey	Dr. Henry B. Kummel, state geologist, Trenton.
New York	Dr. John M. Clarke, state geologist, Albany.
North Carolina	Dr. Jos. Hyde Pratt, state geologist, Chapel Hill.
Virginia	Dr. Thos. L. Watson, director, Charlottesville.

SUMMARY OF THE MINERAL PRODUCTION OF THE UNITED STATES IN 1908.

Compiled by W. T. Thom.

GENERAL REMARKS.[a]

The varied character of the units of measurement employed in the mineral industry makes it impossible to compare the outputs of the several minerals, except in the value of the products.

In 1905, for the first time, and in 1906, for the second time, the total value of the domestic mineral production exceeded the enormous sum of $1,500,000,000; and in 1907, for the first time, the still greater sum of $2,000,000,000 was exceeded.

In 1908 the disastrous results of the financial depression of the latter part of 1907 became only too apparent in the decrease in value of the mineral output, which declined for the year to about $1,596,000,000 from over $2,000,000,000 in 1907.

The exact figures for 1908 are $1,595,670,186, as compared with $2,071,607,964 in 1907, with $1,904,007,034 in 1906, with $1,625,135,835 in 1905, and with $1,363,072,345 in 1904; a loss in 1908 from 1907 of $475,937,778, or 22.97 per cent; from 1906 of $308,336,848, or 16.19 per cent; from 1905 of $29,465,649, or 1.81 per cent, and an increase over 1904 of $232,597,841, or 17.06 per cent.

As heretofore, iron and coal are the most important of our mineral products. The value of iron in 1908 was $254,321,000; the value of coal was $532,314,117. The fuels—coal, natural gas, and petroleum—decreased from $789,128,046 in 1907 to $716,660,749 in 1908, a loss of $72,467,297, or 9.18 per cent. Anthracite coal showed a decrease in value of $5,405,207, from $163,584,056 in 1907 to $158,178,849 in 1908. The decrease in value of the bituminous coal output from 1907 was $77,079,574, from $451,214,842 in 1907 to $374,135,268 in 1908, a loss or combined decrease in the value of coal of $82,484,781, or 13.42 per cent.

The loss of $475,937,778 in the total value of our mineral production is due to losses in both metallic and nonmetallic products, the metallic products showing a decrease from $903,802,244 in 1907 to $549,923,116 in 1908, a loss of $353,879,128, and the nonmetallic products showing a decrease from $1,167,705,720 in 1907 to $1,045,497,070 in

[a] The imports cited in this summary and in the volume are "imports for consumption," which may or may not be identical with the "total imports" for the calendar year. Merchandise brought into the country late in December, for example, may be entered for consumption or it may be put into a warehouse and not be withdrawn for consumption until some months later. It will then be credited for consumption to the year of its withdrawal from the warehouse.

1908, a loss of $122,208,650. To these products should be added estimated unspecified products, including cadmium, nickel, cobalt, bismuth, and other mineral products, valued at $250,000, making a total mineral production for 1908 of $1,595,670,186.

METALS.

Iron and steel.—Twenty-three States produced pig iron in 1908, as against 21 in 1907, 20 in 1906, 20 in 1905, 20 in 1904, 22 in 1903, and 22 in 1902. The total production of pig iron in 1908 was 15,936,018 long tons against 25,781,361 long tons in 1907, 25,307,191 long tons in 1906, 22,992,380 long tons in 1905, 16,497,033 long tons in 1904, and 18,009,252 tons in 1903. The production of 1908 shows a decrease in quantity of 9,845,343 long tons, or 38.19 per cent from the production of 1907, and a decrease in value from $529,958,000 to $254,321,000, amounting to $275,637,000, or 52.01 per cent. The average price per long ton of pig iron decreased from $20.56 in 1907 to $15.96 in 1908. The average prices per long ton in recent years have been as follows: 1906, $19.98; 1905, $16.63; 1904, $14.13. The imports of pig iron (including scrap, valued at $151,012 in 1907 and at $42,715 in 1908) were about 340,000 long tons, valued at $5,480,000 in 1907, and about 36,000 long tons, valued at $540,000 in 1908. The exports (including scrap) were 99,000 long tons, valued at $1,908,000 in 1907 and 68,000 tons, valued at $1,118,000 in 1908.

Iron ores.—The production of iron ores in 1908 amounted to 35,983,336 long tons, as compared with 51,720,619 long tons in 1907, with 47,749,728 long tons in 1906, with 42,526,133 long tons in 1905, with 27,644,330 long tons in 1904, and with 35,019,308 long tons in 1903. The value of the ore mined in 1908 at the mines was $81,845,904, as compared with $131,996,147 in 1907, with $100,597,106 in 1906, and with $75,165,604 in 1905. As in the nine preceding years, the production of iron ores in the United States in 1908 was never equaled by that of any other country. The imports of iron ores in 1908 were valued at $2,220,132 against $3,937,483 in 1907; the exports in 1908 were valued at $1,012,924 against $763,422 in 1907.

Manganese ores.—The production of manganese ores was 3,146 long tons, valued at $29,466 in 1904; 4,118 long tons, valued at $36,214 in 1905; 6,921 long tons, valued at $88,132 in 1906; 5,604 long tons, valued at $63,369 in 1907, and 6,144 tons, valued at $62,779 in 1908. The average price per ton was $9.37 in 1904, $8.80 in 1905, $12.73 in 1906, $11.31 in 1907, and $10.22 in 1908. Manganiferous ores, carrying from 20 to 40 per cent of manganese, were produced to the extent of 55,620 long tons, valued at $132,556 in 1908, as against 103,844 long tons, valued at $259,473 in 1907, and 41,300 long tons, valued at $122,400 in 1906. The imports in 1908 were 178,203 long tons, valued at $1,350,223, as against 209,421 long tons, valued at $1,793,143, in 1907.

Gold.—The production of gold increased from 3,892,480 ounces, valued at $80,464,700 in 1904, to 4,265,742 ounces, valued at $88,180,700 in 1905, and to 4,565,333 ounces, valued at $94,373,800 in 1906; it decreased in 1907 to 4,374,827 ounces, valued at $90,435,700, a loss in 1907 of 190,506 ounces in quantity and of $3,938,100 in value. In 1908 the output increased to 4,574,340 ounces, valued at $94,560,000, a gain of 199,513 ounces in quantity and of $4,124,300 in value.

Silver.—The production of silver increased in quantity from 57,682,800 ounces in 1904 to 56,101,600 ounces in 1905, and to 56,517,900 ounces in 1906; it decreased to 56,514,700 ounces in 1907 and to 52,440,800 ounces in 1908, a loss of 4,073,900 ounces. It increased in commercial value from $33,456,000 in 1904 to $34,221,976 in 1905, and to $38,256,400 in 1906, and decreased to $37,299,700 in 1907, a loss of $956,700, and to $28,050,600 in 1908, a further loss of $9,249,100 in 1908.

Copper.—The production of copper increased from 812,537,267 pounds, valued at $105,629,845, in 1904, to 901,907,843 pounds, valued at $139,795,716, in 1905, and to 917,805,682 pounds, valued at $177,595,888, in 1906; decreased in 1907 to 868,996,491 pounds, valued at $173,799,300; increased in 1908 in quantity to 942,570,721 pounds, and decreased in value to $124,419,335. The imports in 1908 were valued at $29,664,129, against $46,912,347 in 1907. The exports were valued at $91,809,675 in 1908 and at $103,252,917 in 1907.

Lead.—The production of lead in 1908 was 310,762 short tons, as against 365,166 short tons in 1907, 350,153 short tons in 1906, 302,000 short tons in 1905, and 307,000 short tons in 1904. The value of the production in 1908 was $26,104,008, as compared with $38,707,596 in 1907, with $39,917,442 in 1906, with $28,690,000 in 1905, and with $26,402,000 in 1904. The imports of lead were valued at $526,244 in 1908, against $1,082,944 in 1907, and the exports were valued at $599,640 in 1908, against $686,096 in 1907.

Zinc.—The production of zinc in 1908 was 190,749 short tons, as against 223,745 short tons in 1907, 199,694 short tons in 1906, 203,849 short tons in 1905, and 186,702 short tons in 1904. The value of the zinc production in 1908 was $17,930,406, as compared with $26,401,910 in 1907, with $24,362,668 in 1906, with $24,054,182 in 1905, and with $18,670,200 in 1904. The imports of zinc were valued at $617,325 in 1908, against $1,740,059 in 1907; the exports were valued at $1,683,887, against $1,401,831 in 1907.

Bauxite.—In 1908 the production of bauxite was 52,167 long tons, valued at $263,968, as compared with 97,776 long tons, valued at $480,330, in 1907; with 75,332 long tons, valued at $368,311, in 1906; with 48,129 long tons, valued at $240,292, in 1905; with 47,661 long tons, valued at $235,704, in 1904. The imports for consumption in 1908 were 21,679 long tons, valued at $87,823, as against 25,066 long tons, valued at $93,208, in 1907.

Aluminum.—The consumption of aluminum during 1908 was 11,152,000 pounds, valued at $2,434,600, as against 17,211,000 pounds, valued at $4,926,948, in 1907; 14,910,000 pounds, valued at $4,262,286, in 1906; 11,347,000 pounds, valued at $3,246,300, in 1905; and 8,600,000 pounds, valued at $2,477,000, in 1904.

Quicksilver.—The production of quicksilver during 1908 amounted to 19,752 flasks (of 76½ avoirdupois pounds net; 75 avoirdupois pounds net after June, 1904), as against 21,567 flasks in 1907, 26,238 flasks in 1906, 30,451 flasks in 1905, and 34,570 flasks in 1904. The value of the quicksilver produced in 1908 was $824,146 as compared with $828,931 in 1907, with $958,634 in 1906, with $1,103,120 in 1905, and with $1,503,795 in 1904. California reported 16,984 flasks, as against 17,431 flasks in 1907, 20,310 flasks in 1906, 24,635 flasks in 1905, and 29,217 flasks in 1904; and Texas reported 2,382 flasks

as against 3,686 flasks in 1907, 4,761 flasks in 1906, 4,723 flasks in 1905, and 5,336 flasks in 1904. Utah did not report any production, as against 450 flasks in 1907, and 1,164 flasks in 1906. Oregon and Arizona combined reported 386 flasks, as against no production in 1907, and 3 flasks from Oregon in 1906.

Chromic iron ore.—California was the only State producing chromite commercially during 1908, the quantity being 359 long tons, valued at $7,230, as compared with 290 long tons, valued at $5,640, in 1907, with 107 long tons, valued at $1,800, in 1906; with 22 long tons, valued at $375, in 1905; and with 123 long tons, valued at $1,845, in 1904. The imports were 27,876 long tons, valued at $345,960, as against 41,989 long tons, valued at $491,925, in 1907.

Molybdenum.—No production of molybdenum was reported in 1908. There was a small commercial production in 1907, as in 1906 and 1905.

Nickel.—The production of nickel in 1908 is included under unspecified products. There was no production of metallic nickel reported in 1907, as in 1906 and 1905, only a small quantity of nickel and cobalt ore being reported as sold. In 1904 the output was 24,000 pounds, as against a production of 114,200 pounds in 1903, and of 5,748 pounds in 1902. The value in 1904 was $11,400, as against $45,900 in 1903, and $2,701 in 1902. The imports of nickel in 1908 were valued at $2,497,585, as against $2,243,026, in 1907, and $1,902,367 in 1906.

Rutile.—No production of rutile was reported in 1908; there was a small output from Virginia in 1907.

Tungsten.—The commercial production of concentrated tungsten ores during 1908 amounted to 671 short tons, valued at $229,955, as against 1,640 short tons, valued at $890,048, in 1907; 928 short tons, valued at $348,867, in 1906; 803 short tons, valued at $268,676, in 1905; and 740 short tons, valued at $184,000, in 1904.

Uranium and vanadium.—There was no production of uranium and vanadium minerals in 1908. The production in 1907, as in 1906, was included under unspecified products. The production in 1905 was valued at $375, as against $10,600 in 1904 and $5,625 in 1903.

Tantalum.—No output of tantalum was reported in 1908; a very small production was reported from South Dakota in 1907.

Platinum.—The production of platinum from domestic ores in 1908 was 750 ounces, valued at $14,250, as compared with 357 ounces, valued at $10,589, in 1907; with 1,439 ounces, valued at $45,189, in 1906; with 318 ounces, valued at $5,320, in 1905; with 200 ounces, valued at $4,160, in 1904; and with 110 ounces, valued at $2,080, in 1903. The average price per ounce for 1907 was $29.66; in 1908 it was $16.80. The imports of platinum in 1908 were valued at $1,229,873, as against $2,684,642 in 1907.

Antimony.—There was no production of antimony reported in 1908. The production in 1907 was 351 short tons, valued at $77,300, as compared with 1,766 short tons, valued at $602,949, in 1906; with 3,240 short tons, valued at $705,787, in 1905; and 3,057 short tons, valued at $505,524, in 1904. The imports of antimony (metal, regulus, and ore) in 1908 were valued at $878,136, as against $1,588,764 in 1907; imports of antimony salts in 1908 were valued at $65,898, as against $98,038 in 1907.

Antimonial lead.—The output and value of antimonial lead are reported separately for the first time in this report. The production

for 1908 was 13,629 short tons, valued at $1,264,771, against 9,910 short tons, valued at $1,322,985, in 1907.

Bismuth.—There was a small production of bismuth in 1908; no production was reported in 1907. The marketed production of bismuth ore in 1906 was 8,334 pounds, valued at $12,500; in 1905 it was 24,405 pounds, valued at $4,187; in 1904 it was 5,184 pounds, valued at $314. The imports in 1908 were valued at $257,397, as against $325,015 in 1907.

Tin.—No production of metallic tin was reported for 1908. A few tons of stream tin were produced from Buck Creek, Alaska, and were shipped to Hamburg, Germany. There was a very small production of metallic tin in South Dakota in 1907 which, with concentrates from Alaska, from South Dakota, and from the North Carolina-South Carolina deposits, was valued at $33,285, against $35,600 in 1906. The imports of tin in 1908 were valued at $24,128,322, as against $32,151,720 in 1907.

Cadmium.—Cadmium was produced by the Grasselli Chemical Company, of Cleveland, Ohio, in 1906; there was a small production also in both 1907 and 1908.

Selenium and tellurium.—Selenium is recovered in the anode mud or slimes of the electrolytic copper refineries, particularly at Baltimore, Md., and at Perth Amboy and Chrome, N. J.; but no commercial output has been reported. Tellurium is found combined in large quantities with gold and silver at Cripple Creek, Colo., in smaller quantities at other mining camps of the West, and also in the mud or slimes of electrolytic copper refineries.

FUELS.

Coal.—The history of the coal mining industry in 1908 was in marked contrast to that of 1907. For the third time in the history of the United States the production of coal reached in 1908 a total of over 400,000,000 short tons, but the output fell from 480,363,424 tons of 2,000 pounds, valued at $614,798,898, in 1907, to 415,842,698 short tons, valued at $532,314,117, in 1908—a decrease of 64,520,726 short tons, or 13.43 per cent, in quantity, and of $82,484,781, or 13.42 per cent, in value. Of this total, the output of anthracite coal amounted to 74,347,102 long tons (equivalent to 83,268,754 short tons), which, as compared with the production of 76,432,421 long tons in 1907, was a decrease of 2,085,319 long tons, or 2.73 per cent. The value of anthracite coal at the mines in 1908 was $158,178,849, as against $163,584,056 in 1907, $131,917,694 in 1906, $141,879,000 in 1905, and $138,974,020 in 1904—a decrease in 1908, as compared with 1907, of $5,405,207, or 3.3 per cent. The average price of the marketed anthracite coal sold during the 1908 season at the mines was the same as in 1907, $2.35 per long ton, as against $2.30 per long ton in 1906, $2.25 in 1905, and $2.35 in 1904.

The output of bituminous coal (which includes semianthracite and all semibituminous and lignite coals) amounted in 1908 to 332,573,944 short tons, valued at $374,135,268, as compared with 394,759,112 short tons, valued at $451,214,842, in 1907; with 342,874,867 short tons, valued at $381,162,115, in 1906; with 315,062,785 short tons, valued at $334,658,294, in 1905; and with 278,659,689 short tons, valued at $305,397,001, in 1904. The decrease in the production of

bituminous coal in 1908 from 1907 was therefore 62,185,168 short tons, or 15.75 per cent, in quantity, and $77,079,574, or 17.08 per cent, in value. The average price of bituminous coal per ton at the mines during 1908 was $1.12 as against $1.14 in 1907, $1.11 in 1906, $1.06 in 1905, $1.10 in 1904, and $1.24 in 1903—the highest price recorded by the Survey. The imports of anthracite in 1908 were valued at $73,778, against $40,971 in 1907; the imports of bituminous were valued at $3,964,843, against $5,397,222 in 1907. The exports were in 1908: Anthracite, $13,524,595; bituminous, $23,361,914; in 1907: Anthracite, $13,217,985; bituminous, $26,972,908.

Coal briquets.—The production of coal briquets in the United States in 1908 was 90,358 short tons, valued at $323,057, as compared with 66,524 short tons, valued at $258,426, in 1907.

Coke.—The coke production of the United States in 1908, which included the output—4,201,226 short tons—from 3,679 retort or by-product ovens, amounted to 26,033,518 short tons, as compared with 40,779,564 short tons in 1907, with 36,401,217 short tons in 1906, with 32,231,129 short tons in 1905, and with 23,661,106 short tons in 1904. The decrease in quantity from 1907 to 1908 was 14,746,046 short tons, or 36.14 per cent. The total value was $62,483,983 as against $111,539,126 in 1907, a loss of $49,055,143, or 43.98 per cent. The average price per ton in 1908 was $2.40, against $2.74 in 1907. The average output from the by-product ovens in 1908 was 1,142 tons per oven, against an average of 258 tons per oven from the beehive ovens. The imports of coke were valued at $606,294 in 1908, against $596,366 in 1907, and the exports were valued at $2,161,032 in 1908, against $3,206,793 in 1907.

Gas, coke, tar, and ammonia.—The aggregate value of all the products obtained from the distillation of coal in gas works and retort ovens in 1905 was $56,684,972, as against $51,157,736 in 1904 and $47,830,600 in 1903. No report was prepared for 1906. The aggregate value in 1907 was $73,573,004; in 1908 it was $64,660,040. The imports of ammonium sulphate in 1908 were valued at $2,036,270, as against $1,915,908 in 1907. The imports of coal-tar products in 1908 were valued at $7,044,585, as against $8,846,401 in 1907.

Natural gas.—The value of the natural gas produced in 1908 was $54,640,374, as compared with $54,222,399 in 1907, with $46,873,932 in 1906, with $41,562,855 in 1905, and with $38,496,760 in 1904.

Petroleum.—The total production of crude petroleum in the United States in 1908 was 179,572,479 barrels, as against 166,095,335 barrels in 1907, against 126,493,936 barrels in 1906, against 134,717,580 barrels in 1905, and against 117,080,960 barrels in 1904—an increase in 1908 of 13,477,144 barrels or 8.11 per cent over the production of 1907. Among the noteworthy changes in production in 1908 were gains, as compared with 1907, of over 6,000,000 barrels in the Illinois field, and of over 5,000,000 barrels in California.

The value of crude petroleum produced during 1908 was $129,706,258, as against $120,106,749 in 1907, or 72.3 cents per barrel, in both years; against $92,444,735, or 73.1 cents per barrel, in 1906; against $84,157,399, or 62.47 cents per barrel, in 1905; and against $101,175,455, or 86.41 cents per barrel, in 1904. The imports of petroleum in 1908 were valued at $617,659, as against $286,252 in 1907; the exports in 1908 were $108,815,455, as against $91-383,064 in 1907. The imports of ozokerite and paraffin in 1908

were valued at $438,628, as against $186,182 in 1907; the exports were valued in 1908 at $6,922,638, as against $10,209,448 in 1907.

Peat.—The commercial production of peat in 1908 in the forms of peat fertilizer filler, peat fuel, and peat moss litter was valued at $133,000. It would seem that the conversion of raw bog peat into these three commercial forms is now to be reported as an established industry in this country. The imports of peat moss litter have averaged about $45,000 for the last three years.

STRUCTURAL MATERIALS.

Cement.—The total production of hydraulic cement in the United States in 1908 was 52,910,925 barrels, valued at $44,477,653, compared with 52,230,342 barrels, valued at $55,903,851, in 1907; with 51,000,445 barrels, valued at $55,302,277, in 1906; with 40,102,308 barrels, valued at $35,931,533, in 1905; and with 31,675,257 barrels, valued at $26,031,920, in 1904. The Portland cement production in 1908 was 51,072,612 barrels, valued at $43,547,679, as compared with 48,785,390 barrels, valued at $53,992,551, in 1907; with 46,463,424 barrels, valued at $52,466,186, in 1906; with 35,246,812 barrels, valued at $33,245,867, in 1905; and with 26,505,881 barrels, valued at $23,355,119, in 1904—an increase in quantity in 1908, as compared with 1907, of 2,287,222 barrels, and a decrease in value of $10,444,872. The production of natural cement in 1908 was 1,686,682 barrels, valued at $834,509, as compared with 2,887,700 barrels, valued at $1,467,302, in 1907; with 4,055,797 barrels, valued at $2,423,170, in 1906; with 4,473,049 barrels, valued at $2,413,052, in 1905; and with 4,866,331 barrels, valued at $2,450,150, in 1904—a decrease in 1908 of about 41 per cent in quantity and of about 43 per cent in value. The production of puzzolan cement in 1908 amounted to 151,451 barrels, valued at $95,468, as against 557,252 barrels, valued at $443,998, in 1907; against 481,224 barrels, valued at $412,921, in 1906; against 382,447 barrels, valued at $272,614, in 1905; and against 303,045 barrels, valued at $226,651, in 1904. The imports of hydraulic cement in 1908 were valued at $1,206,832, as compared with $2,614,228 in 1907; the exports were valued at $1,249,229 in 1908 against $1,450,841 in 1907.

Clay products.—The value of all clay products in 1908, as reported to this office was $133,197,762, as against $158,942,369 in 1907, $161,032,722 in 1906, $149,697,188 in 1905, and $131,023,248 in 1904. The brick and tile products in 1908 were valued at $108,062,207, as compared with $128,798,895 in 1907, $129,591,838 in 1906, $121,778,294 in 1905, and $105,864,978 in 1904. The pottery products were valued at $25,135,555 in 1908, against $30,143,474 in 1907, against $31,440,884 in 1906, against $27,918,894 in 1905, and against $25,158,270 in 1904. The imports of pottery in 1908 amounted to $10,522,791, as against $13,585,612 in 1907.

The commercial production of clay mined and sold in 1908 by those not manufacturing the clay themselves was valued at $2,599,986, as against $3,448,548 in 1907, $3,245,256 in 1906, $2,768,006 in 1905, and $2,320,162 in 1904. The imports of clay amounted in 1908 to $189,454, as against $337,539 in 1907. The imports of kaolin or china clay in 1908 were valued at $1,129,847, as against $1,582,893 in 1907.

Lime.—The production of lime in 1908 was 2,766,873 short tons, valued at $11,091,186, as against 3,092,524 short tons, valued at $12,656,705, in 1907; 3,198,087 short tons, valued at $12,480,653, in 1906; 2,984,100 short tons, valued at $10,941,680, in 1905; and 2,707,809 short tons, valued at $9,951,456, in 1904. The average price per short ton was $3.90 in 1906, $4.09 in 1907, and $4.01 in 1908.

Sand-lime brick.—The production of sand-lime brick in 1908 was valued at $961,226, as against $1,225,769 in 1907, $1,170,005 in 1906, $972,064 in 1905, and $463,128 in 1904.

Slate.—The production of slate in 1908 was valued at $6,316,817, as against $6,019,220 in 1907, $5,668,346 in 1906, $5,496,207 in 1905, and $5,617,195 in 1904. The imports of slate in 1908 were valued at $7,227, against $5,404 in 1907; the exports of roofing slate were valued at $197,216, against $220,995 in 1907.

Stone.—The value of all kinds of stone produced in the United States during 1908 amounted to $65,712,499, as compared with $71,105,805 in 1907, $66,378,794 in 1906, $63,798,748 in 1905, and with $58,765,275 in 1904.

Included under stone is the limestone used for fluxing in blast furnaces, which in 1908 was 11,091,442 long tons, valued at $5,905,241, as compared with 17,119,297 long tons, valued at $9,144,489, in 1907; 16,077,202 long tons, valued at $7,612,692, in 1906; 15,387,891 long tons, valued at $7,004,265, in 1905; and 10,657,038 long tons, valued at $4,702,768, in 1904.

ABRASIVE MATERIALS.

Artificial abrasives.—The total production of artificial abrasives, alundum, carborundum, and crushed steel, in 1908 amounted to 8,698,000 pounds, valued at $626,340, as against 14,632,000 pounds, valued at $1,027,246, in 1907, and 11,774,300 pounds, valued at $777,081, in 1906.

Corundum and emery.—The combined production of corundum and emery in 1908 amounted to 669 short tons, valued at $8,745, as against 1,069 short tons, valued at $12,294, in 1907; 1,160 short tons, valued at $44,310, in 1906; 2,126 short tons, valued at $61,464, in 1905; and 1,916 short tons, valued at $56,985, in 1904. The imports in 1908 were valued at $248,399, against $412,630, in 1907.

Abrasive quartz and feldspar.—In 1908 the production of abrasive quartz and feldspar amounted to 11,725 short tons, valued at $79,146, as against 17,435 short tons, valued at $126,582, in 1907; 24,082 short tons, valued at $121,671, in 1906; 19,039 short tons, valued at $88,118, in 1905; and 31,940 short tons, valued at $74,850, in 1904.

Garnet.—The production of abrasive garnet during 1908 amounted to 1,996 short tons, valued at $64,620, as against 7,058 short tons, valued at $211,686, in 1907; 4,650 short tons, valued at $157,000, in 1906; 5,050 short tons, valued at $148,095, in 1905; and 3,854 short tons, valued at $117,581, in 1904. The average price was about $32.37 per ton, as against $30 per ton in 1907.

Grindstones.—The total value of all kinds of grindstones and pulp stones produced during 1908 was $536,095, as against $896,022 in 1907, $744,894 in 1906, $777,606 in 1905, and $881,527 in 1904. The imports in 1908 were valued at $80,382; in 1907, at $111,495.

Infusorial earth and tripoli.—In 1908 the value of the infusorial earth and tripoli production was $97,442, as against $104,406 in 1907. In 1906 the production of infusorial earth and tripoli amounted to 8,099 short tons, valued at $72,108, as against 10,977 short tons, valued at $64,637, in 1905, and 6,274 short tons, valued at $44,164, in 1904. The imports of rotten stone and tripoli in 1908 were valued at $17,252 and at $27,121 in 1907.

Millstones and buhrstones.—The value of the production of millstones and buhrstones in 1908 was $31,420, as against $31,741 in 1907, $48,590 in 1906, $37,974 in 1905, and $37,338 in 1904. The imports were valued at $18,642 in 1908, and at $27,308 in 1907.

Oilstones and whetstones.—The production of oilstones and whetstones in 1908 was valued at $217,284, against $264,188 in 1907. The value rose from $188,985 in 1904 to $244,546 in 1905 and to $268,070 in 1906. The imports were valued at $44,304 in 1908 and at $89,939 in 1907.

Pumice.—The production of pumice amounted in 1908 to 10,569 short tons, valued at $39,287, against 8,112 short tons, valued at $33,818, in 1907; against 12,200 short tons, valued at $16,750, in 1906; 1,832 short tons, valued at $5,540, in 1905, and against 1,530 short tons, valued at $5,421, in 1904. The imports were valued at $67,094 in 1908, at $85,647 in 1907, and at $111,695 in 1906.

CHEMICAL MATERIALS.

Arsenious oxide.—The domestic production of arsenious oxide (white arsenic) in 1908 was considerably less in both quantity and value than the production of 1907, which was 3,502,000 pounds, valued at $163,000, as compared with 1,474,000 pounds, valued at $63,460, in 1906; 1,507,386 pounds, valued at $35,210, in 1905; and 72,413 pounds, valued at $2,185, in 1904. The imports of white arsenic, metallic arsenic, and arsenic sulphide in 1908 were valued at $430,400, as against $574,998 in 1907.

Borax.—The reported returns for 1908 gave an aggregate production of crude borax of 25,000 short tons, valued at $975,000, as compared with 52,850 short tons, valued at $1,121,520, in 1907; 58,173 short tons, valued at $1,182,410, in 1906; 46,334 short tons, valued at $1,019,154, in 1905; and 45,647 short tons, valued at $698,810, in 1904. Only high-grade colemanite was worked in 1908, which accounts for higher valuation with lessened tonnage. The imports of borax in 1908 were valued at $36,764, as against $100,980 in 1907.

Bromine.—The production of bromine in 1908, including the bromine contained in potassium bromide, amounted to 1,055,636 pounds, valued at $102,344, as compared with 1,379,496 pounds, valued at $195,281, in 1907; 1,283,250 pounds, valued at $165,204, in 1906; 1,192,758 pounds, valued at $178,914, in 1905; and 897,100 pounds, valued at $269,130, in 1904.

Fluorspar.—The total commercial production of fluorspar in 1908 was 38,795 short tons, valued at $225,998, as compared with 49,486 short tons, valued at $287,282, in 1907; with 40,796 short tons, valued at $244,025, in 1906; with 57,385 short tons, valued at $362,488, in 1905; and with 36,452 short tons, valued at $234,755, in 1904. It is estimated that the imports in 1908 amounted to about 22,000 short tons.

Gypsum.—The output of crude gypsum in 1908 was 1,721,829 short tons, valued in its first marketable condition at $4,138,560, as compared with 1,751,748 short tons, valued at $4,942,264, in 1907; with 1,540,585 short tons, valued at $3,837,975, in 1906; with 1,043,202 short tons, valued at $3,029,227, in 1905; and with 940,917 short tons, valued at $2,784,325, in 1904. The greatly increased production of late years is attributable to the largely increased use of wall plaster and of plaster of Paris in large modern buildings. The imports in 1908 were valued at $354,403, against $535,658 in 1907.

Lithium minerals.—The production of lithium minerals in 1908 was 203 short tons, valued at $1,550, as against 530 short tons, valued at $11,000, in 1907; 383 short tons, valued at $7,411, in 1906; 79 short tons, valued at $1,412, in 1905; and 577 short tons, valued at $5,155, in 1904.

Marls.—The production of marls in the United States in 1908 was 8,469 short tons, valued at $4,330, as compared with 14,091 short tons, valued at $8,429, in 1907; 19,104 short tons, valued at $7,341, in 1906; 38,026 short tons, valued at $16,494, in 1905; and 18,989 short tons, valued at $13,145, in 1904.

Phosphate rock.—The total commercial production of phosphate rock reported to the Survey in 1908 amounted to 2,386,138 long tons, valued at $11,399,124, as compared with 2,265,343 long tons, valued at $10,653,558, in 1907; with 2,080,957 long tons, valued at $8,579,437, in 1906; with 1,947,190 long tons, valued at $6,763,403, in 1905; with 1,874,428 long tons, valued at $6,580,875, in 1904. The total quantity of phosphate rock reported as mined during 1908 was 2,661,459 long tons, as against 2,356,486 long tons mined in 1907, 2,001,394 long tons mined in 1906, 2,138,309 long tons mined in 1905, and 1,991,169 long tons mined in 1904. The imports for consumption of crude phosphate were 14,311 long tons, valued at $82,863, against 25,745 long tons, valued at $164,343, imported in 1907. The exports were 1,188,411 long tons, valued at $9,294,009, against 1,018,212 long tons, valued at $8,387,176, in 1907.

Salt.—The salt product includes salt in the form of brine used in large quantities for the manufacture of soda ash, sodium bicarbonate, caustic soda, and other sodium salts. The domestic production of salts in 1908 amounted to 28,822,062 barrels of 280 pounds, valued at $7,553,632, as compared with 29,704,128 barrels, valued at $7,608,323, in 1907; with 28,172,380 barrels, valued at $6,658,350, in 1906; with 25,966,122 barrels, valued at $6,095,922, in 1905; and with 22,030,002 barrels, valued at $6,021,222, in 1904. The imports amounted in 1908 to 319,285,638 pounds, valued at $444,690, against 297,598,394 pounds, valued at $451,282, in 1907. The exports in 1908 were valued at $202,338, against $232,895 in 1907.

Sulphur and pyrite.—The domestic production of sulphur in 1908 was 369,444 long tons, valued at $6,668,215, as against 293,106 long tons, valued at $5,142,850, in 1907; against 294,153 long tons, valued at $5,096,678, in 1906; the production of pyrite was 222,598 long tons, valued at $857,113, as against 247,387 long tons, valued at $794,949, in 1907; against 261,422 long tons, valued at $931,305, in 1906. The combined production of sulphur and pyrite for the manufacture of sulphuric acid amounted to 434,677 long tons, valued at $4,645,052, in 1905; and to 334,373 long tons, valued at $3,478,568 in 1904. The production of domestic sulphur, chiefly from Louisiana

rose in value from $2,663,760 in 1904 to $6,668,215 in 1908; the imports fell in value from $2,511,269 in 1904 to $362,379 in 1908. The exports in 1908 exceeded the imports for consumption by about 7,000 tons. Thus to-day this country is more than supplying its demand for sulphur, a thing regarded as impossible a few years ago.

PIGMENTS.

Barytes.—The production of crude barytes in 1908 was 38,527 short tons, valued at $120,442, as compared with 89,621 short tons, valued at $291,777, in 1907; with 50,231 short tons, valued at $160,367, in 1906; with 48,235 short tons, valued at $148,803, in 1905; and with 65,727 short tons, valued at $174,958, in 1904. The output in 1908 decreased nearly 57 per cent from that of 1907. The imports of barytes fell from $173,425 in 1907 to $87,990 in 1908, and of barium compounds from $357,117 to $319,114.

Cobalt oxide.—The production of cobalt oxide in 1908 is included under unspecified products. A production was reported from Oregon and Missouri in 1907. No production was reported in 1905 and 1906. In 1904 the output was reported as 22,000 pounds, valued at $42,600; in 1903 it was 120,000 pounds, valued at $228,000. The imports in 1908 were valued at $16,846, as against $74,849 in 1907.

Mineral paints.—The commercial production of mineral paints in 1908 amounted to 68,694 short tons, valued at $2,410,367, as compared with 71,973 short tons, valued at $2,979,158, in 1907; with 66,033 short tons, valued at $2,161,461, in 1906; with 70,355 short tons, valued at $1,932,048, in 1905; and with 64,592 short tons, valued at $1,448,551, in 1904.

Zinc oxide.—The production of zinc oxide in 1908 amounted to 56,292 short tons, valued at $5,072,460, as compared with 71,784 short tons, valued at $6,490,660, in 1907; with 74,680 short tons, valued at $5,999,375, in 1906; with 68,603 short tons, valued at $5,520,240, in 1905; and with 63,363 short tons, valued at $4,808,482, in 1904. The imports of zinc oxide in 1908 were valued at $297,674, as against $357,230 in 1907; the exports were valued at $845,070, as against $1,069,924 in 1907.

MISCELLANEOUS.

Asbestos.—The asbestos commercially produced in the United States in 1908 was obtained from deposits in Georgia and Vermont, with a small quantity from Arizona. The total commercial production was 936 short tons, valued at $19,624, as against 653 short tons, valued at $11,899, in 1907; against 1,695 short tons, valued at $28,565, in 1906; against 3,109 short tons, valued at $42,975, in 1905; and against 1,480 short tons, valued at $25,740, in 1904. The imports for consumption were valued at $1,195,870 in 1908, as against $1,304,480 in 1907.

Asphalt.—Under this title are included the various bitumens or hydrocarbons not discussed elsewhere under the heading "Petroleum." The commercial production in 1908 was 185,382 short tons, valued at $1,888,881, as compared with 223,861 short tons, valued at $2,826,489, in 1907; against 138,059 short tons, valued at $1,290,-

340, in 1906; 115,267 short tons, valued at $758,153, in 1905; and 108,572 short tons, valued at $879,836, in 1904. The imports of asphalt in 1908 were valued at $624,979, as against $645,464 in 1907.

Feldspar.—The production of feldspar in 1908 was 67,240 short tons, valued at $400,918, as against 84,549 short tons, valued at $499,069, in 1907; against 75,656 short tons, valued at $401,531, in 1906; 35,419 short tons, valued at $226,157, in 1905; and 45,188 short tons, valued at $266,326, in 1904.

Fertilizers.—Fertilizers, including apatite, bone dust, guano, kieserite, and other manures, valued at $1,893,732, were imported in 1908, as against the same substances imported and valued at $5,342,138 in 1907.

Fibrous talc.—This variety of talc, or soapstone, occurs in but one locality in the United States—Gouverneur, St. Lawrence County, N. Y. It is used principally as makeweight in the manufacture of paper. In 1908 the production was 70,739 short tons, valued at $697,390, as against 67,800 short tons, valued at $626,000, in 1907; against 61,672 short tons, valued at $557,200, in 1906; 56,500 short tons, valued at $445,000, in 1905; and 64,005 short tons, valued at $507,400, in 1904.

Fuller's earth.—As reported to the Survey, the production of fuller's earth in 1908 was 29,714 short tons, valued at $278,367, as against 32,851 short tons, valued at $291,773, in 1907; 32,040 short tons, valued at $265,400, in 1906; 25,178 short tons, valued at $214,497, in 1905; and 29,480 short tons, valued at $168,500, in 1904. The imports in 1908 were valued at $93,413, as against $122,221 in 1907.

Glass sand.—The production of glass sand in 1908 was 1,093,553 short tons, valued at $1,134,599, as against 1,187,296 short tons, valued at $1,250,067, in 1907; against 1,089,430 short tons, valued at $1,208,788, in 1906; 1,060,334 short tons, valued at $1,107,730, in 1905; and against 858,719 short tons, valued at $796,492, in 1904.

Graphite.—The commercial production of crystalline graphite during 1908 amounted to 2,288,000 pounds, valued at $132,840, as compared with 4,947,840 pounds, valued at $171,149, in 1907; with 5,887,982 pounds, valued at $238,064, in 1906; with 6,036,567 pounds, valued at $237,572, in 1905; and with 5,681,177 pounds, valued at $238,447, in 1904. The production of amorphous graphite in 1908 was 1,443 short tons, valued at $75,250, as compared with 26,803 short tons, valued at $125,821, in 1907; with 16,853 short tons, valued at $102,175, in 1906; with 21,953 short tons, valued at $80,639, in 1905; and with 16,927 short tons, valued at $82,925, in 1904. The production of artificial graphite in 1908 was 7,385,511 pounds, valued at $502,667, the average price being 6.8 cents per pound, as compared with 6,590,000 pounds, valued at $481,239, the average price being 7.3 cents per pound, in 1907; with 5,074,757 pounds, valued at $337,204, the average price being 6.64 cents per pound, in 1906; with 4,591,550 pounds, valued at $313,980, the average price being 6.84 cents per pound, in 1905; and with 3,248,000 pounds, valued at $217,790, the average price being 6.71 cents per pound, in 1904. The imports of graphite in 1908 were valued at $762,367, as against $1,777,389 in 1907, $1,554,212 in 1906, and $983,034 in 1905.

Magnesite.—The production of crude magnesite in the United States continues to be limited to California. During the year 1908 the commercial production reported was 6,587 short tons, valued at $19,761, as against 7,561 short tons, valued at $22,683, in 1907; 7,805 short tons, valued at $23,415, in 1906; 3,933 short tons, valued at $15,221, in 1905; and 2,850 short tons, valued at $9,298, in 1904. The imports of magnesite and magnesia in 1908 were valued at $775,642, as against $918,946 in 1907.

Mica.—The total production of mica in 1908 was 972,964 pounds of sheet mica, valued at $234,021, and 2,417 short tons of scrap mica, valued at $33,904, as against 1,060,182 pounds of sheet mica, valued at $349,311, and 3,025 short tons of scrap mica, valued at $42,800, in 1907; against 1,423,100 pounds of sheet mica, valued at $252,248, and 1,489 short tons of scrap mica, valued at $22,742, in 1906; and against 924,875 pounds of sheet mica, valued at $160,732, and 1,126 short tons of scrap mica, valued at $17,856, in 1905. The imports of mica in 1908 were valued at $266,058, as against $925,259 in 1907.

Mineral waters.—The total production of mineral waters in 1908 was 56,108,820 gallons, valued at $7,287,269, as compared with 52,060,520 gallons, valued at $7,331,503, in 1907; with 48,108,580 gallons, valued at $8,028,387, in 1906; with 47,590,081 gallons, valued at $6,811,611, in 1905; and with 50,723,500 gallons, valued at $7,198,450, in 1904. The imports of mineral waters in 1908 were valued at $1,033,047, as against $1,165,555 in 1907.

Monazite and zircon.—The production of monazite is confined to North Carolina and South Carolina exclusively, about five-sixths being obtained from the former State. In 1908 the production was 422,646 pounds of concentrates, valued at $50,718, as against 548,152 pounds of concentrates (including a small quantity of zircon), valued at $65,800, in 1907; against 847,275 pounds of concentrates, valued at $152,560, in 1906. In 1905 the production (including small quantities of zircon and columbite) amounted to 1,352,418 pounds, valued at $163,908, as compared with 745,999 pounds (including small quantities of zircon, columbite, and gadolinite), valued at $85,038, in 1904. The imports of thorium nitrate in 1908 were 65,289 pounds, valued at $173,239, against 51,441 pounds, valued at $152,666, in 1907.

Potassium salts.—There was no production of potassium salts in the United States in 1908 or 1907. The imports were valued at $5,623,752 in 1908, as against $7,038,817 in 1907 and $5,491,217 in 1906.

Precious stones.—The value of the gems and precious stones found in the United States in 1908 was reported as $415,063, against $471,300 in 1907, $208,000 in 1906, $326,350 in 1905, $324,300 in 1904, and $307,900 in 1903. The pearls produced in 1907 were valued at $264,500, as against $381,000 in 1906. No production of pearls was reported for 1908. The imports of precious stones in 1908 were valued at $13,700,404, against $31,866,599 in 1907 and $43,602,476 in 1906.

Quartz.—The production of quartz in 1908 was 38,825 short tons, valued at $138,646, as compared with 22,977 short tons, valued at $157,094, in 1907; with 66,697 short tons, valued at $243,012, in

1906; 51,145 short tons, valued at $104,109, in 1905; and 52,270 short tons, valued at $100,590, in 1904. The value of the unground flint stones imported in 1908 was $219,754, as against $288,371 in 1907.

Sand and gravel.—The production of sand for molding, building, engine, furnace, and other purposes and of gravel reported in 1908 was 36,122,491 short tons, valued at $12,135,433, as against 40,664,622 short tons, valued at $13,242,002, in 1907; against 31,842,572 short tons, valued at $11,489,420, in 1906; 22,144,633 short tons, valued at $10,115,915, in 1905; and 9,821,009 short tons, valued at $4,951,607, in 1904.

Talc and soapstone.—Exclusive of the production of fibrous talc from Gouverneur, N. Y., the production of talc and soapstone in 1908 amounted to 46,615 short tons, valued at $703,832, as compared with 72,010 short tons, valued at $905,047, in 1907; with 58,972 short tons, valued at $874,356, in 1906; with 40,134 short tons, valued at $637,062, in 1905; and with 27,184 short tons, valued at $433,331, in 1904. The imports of talc in 1908 were valued at $97,096, as against $126,391 in 1907.

MINERAL PRODUCTS OF THE UNITED STATES IN 1907 AND 1908.

From the tabular statement headed "Mineral products of the United States in 1907 and 1908," including also the tables for the years 1880 to 1908, all unnecessary duplication has been excluded. The manufactured coke product, amounting in 1908 to 26,033,518 short tons, and valued at $62,483,983, is excluded, as the quantity and value of the coal used in its manufacture are included in the statistics of coal production. Similarly white lead, red lead, lithopone, Venetian red, litharge, and orange mineral, whose average aggregate value for the last ten years has largely exceeded $15,000,000, are not given in the table, the base from which they are made being included in the output of pig lead. Zinc white or zinc oxide, zinc-lead, sublimed blue lead, and sublimed white lead, on the other hand, made directly from the ores, and consequently not included in spelter or lead production, are tabulated. The production of pig iron and its value are given in the table as the best means of presenting the statistics of the production of iron in the first marketable condition, the value of iron ores being excluded. Similarly, the value of the products of the clay industries is given as being the first marketable condition of the greater part of the clay produced, although the production and value of the clay mined and sold in the raw state by clay miners to manufacturers of clay are elsewhere shown separately, but are not included in the tabular statement, in order to avoid duplication.

The figures for gold and silver for 1907 and 1908 are the official figures agreed upon by the United States Geological Survey and the Director of the Mint. The figures for the tonnage (not the value) of pig iron in 1907 and 1908 are from the reports of Mr. James M. Swank, general manager of the American Iron and Steel Association.

Mineral products of the United

	Product.	1907. Quantity.	1907. Value.
	METALLIC.		
1	Pig iron,[a] spot value[b] long tons[c]	25,781,361	$529,958,000
2	Silver, commercial value[d] troy ounces	56,514,700	37,299,700
3	Gold, coining value[e] do	4,374,827	90,435,700
4	Copper, value at New York City pounds	868,996,491	173,799,300
5	Lead,[f] value at New York City short tons	365,166	38,707,596
6	Zinc,[f] value at New York City do	223,745	26,401,910
7	Quicksilver, value at San Francisco flasks[g]	21,567	828,931
8	Aluminum, value at Pittsburg pounds	[h] 17,211,000	4,926,948
9	Antimony,[i] value at San Francisco short tons	351	77,300
10	Antimonial lead do	9,910	1,322,985
11	Nickel,[j] value at Philadelphia pounds		[k]
12	Tin do	[l]	33,285
13	Platinum, value at New York City troy ounces	357	10,589
14	Total value of metallic products		903,802,244
	NONMETALLIC (SPOT VALUES).		
15	Bituminous coal[m] short tons	394,759,112	451,214,842
16	Pennsylvania anthracite long tons	76,432,421	163,584,056
17	Natural gas		54,222,399
18	Petroleum barrels[n]	166,095,335	120,106,749
19	Peat		
20	Clay products[o]		158,942,369
21	Cement barrels[p]	52,230,342	55,903,851
22	Lime short tons	3,092,524	12,656,705
23	Sand-lime brick		1,225,769
24	Slate		6,019,220
25	Stone[q]		71,105,805
26	Corundum and emery short tons	1,069	12,294
27	Abrasive quartz and feldspar do	17,435	126,582
28	Garnet for abrasive purposes do	7,058	211,686
29	Grindstones		896,022
30	Infusorial earth and tripoli		104,406
31	Millstones		31,741
32	Oilstones, etc		264,188
33	Pumice short tons	8,112	33,818
34	Arsenious oxide pounds	3,502,000	163,000
35	Borax (crude) short tons	52,850	1,121,520
36	Bromine pounds	1,379,496	195,281
37	Fluorspar short tons	49,486	287,282
38	Gypsum do	1,751,748	4,942,264
39	Lithium minerals do	530	11,000
40	Marls do	14,091	8,429
41	Phosphate rock long tons	2,265,343	10,653,558
42	Pyrite do	247,387	794,949
43	Sulphur do	293,106	5,142,850
44	Salt barrels[r]	29,704,128	7,608,323
45	Barytes (crude) short tons	89,621	291,777
46	Cobalt oxide pounds		[k]
47	Mineral paints[s] short tons	71,973	2,979,158
48	Zinc oxide do	71,784	6,490,660
49	Asbestos do	653	11,899
50	Asphalt do	223,861	2,826,489
51	Bauxite long tons	97,776	480,330
52	Chromic iron ore do	290	5,640
53	Feldspar short tons	84,549	499,069

[a] Production of iron ore—1899: 24,683,173 long tons; value at mines, $34,999,077. 1900: 27,553,161 long tons, value at mines, $66,590,504. 1901: 28,887,479 long tons; value at mines, $49,256,245. 1902: 35,554,135 long tons; value at mines, $65,412,950. 1903: 35,019,308 long tons; value at mines, $66,328,415. 1904: 27,644,330 long tons; value at mines, $43,186,741. 1905: 42,526,133 long tons; value at mines, $75,165,604. 1906: 47,749,728 long tons; value at mines, $100,597,106. 1907: 51,720,619 long tons; value at mines, $131,996,147. 1908: 35,983,336 long tons; value at mines, $81,845,904. Statistics for iron ore and for value of pig iron are collected by the Survey; statistics for output of pig iron are furnished by the American Iron and Steel Association.

[b] By "spot" value is meant value at the point of production.

[c] Long tons are tons of 2,240 avoirdupois pounds; short tons are tons of 2,000 avoirdupois pounds.

[d] Average price per troy ounce in 1906 was 67 cents; in 1907 it was 66 cents; in 1908 it was 53 cents.

[e] Prior to 1905, coining value, $20.6718 per troy ounce; in 1905, coining value, $20.671834; since 1905, coining value, $20.671834625323.

[f] The products from domestic ores only.

[g] Of 76½ avoirdupois pounds net; of 75 avoirdupois pounds net since June, 1904.

[h] Consumption.

[i] Includes antimony smelted from imported ores and antimony contained in hard lead.

[j] Includes nickel in copper-nickel alloy and in exported ore and matte.

[k] Included under unspecified.

States in 1907 and 1908.

1908.		Increase (+) or decrease (−) in 1908.		Percentage of increase (+) or decrease (−) in 1908.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
15,936,018	$254,321,000	− 9,845,343	−$275,637,000	− 38.19	− 52.01	1
52,440,800	28,050,600	− 4,073,900	− 9,249,100	− 7.21	− 24.80	2
4,574,340	94,560,000	+ 199,513	+ 4,124,300	+ 4.56	+ 4.56	3
942,570,721	124,419,335	+73,574,230	− 49,379,965	+ 8.47	− 28.41	4
310,762	26,104 008	− 54,404	− 12,603,588	− 14.90	− 32.56	5
190,749	17,930,406	− 32,996	− 8,471,504	− 14.75	− 32.09	6
19,752	824,146	− 1,815	− 4,785	− 8.42	− .58	7
[h] 11,152,000	2,434,600	− 6,059,000	− 2,492,348	− 35.20	− 50.59	8
.....	.....	− 351	− 77,300	−100.00	−100.00	9
13,629	1,264,771	+ 3,719	− 58,214	+ 37.53	− 4.40	10
.....	[k]	.....	.....	.....	.....	11
[l]	.....	.....	− 33,285	.....	−100.00	12
750	14,250	+ 393	+ 3,661	+110.08	+ 34.57	13
.....	549,923,116	.....	− 353,879,128	.....	− 39.15	14
332,573,944	374,135,268	−62,185,168	− 77,079,574	− 15.75	− 17.08	15
74,347,102	158,178,849	− 2,085,319	− 5,405,207	− 2.73	− 3.30	16
.....	54,640,374	.....	+ 417,975	.....	+ .77	17
179,572,479	129,706,258	+13,477,144	+ 9,599,509	+ 8.11	+ 7.99	18
.....	133,000	.....	+ 133,000	.....	.....	19
.....	133,197,762	.....	− 25,744,607	.....	− 16.20	20
52,910,925	44,477,653	+ 680,583	− 11,426,198	+ 1.30	− 20.44	21
2,766,873	11,091,186	− 325,651	− 1,565,519	− 10.53	− 12.37	22
.....	961,226	.....	− 264,543	.....	− 21.58	23
.....	6,316,817	.....	+ 297,597	.....	+ 4.94	24
.....	65,712,499	.....	− 5,393,306	.....	− 7.58	25
669	8,745	− 400	− 3,549	− 37.42	− 28.87	26
11,725	79,146	− 5,710	− 47,436	− 32.75	− 37.47	27
1,996	64,620	− 5,062	− 147,066	− 71.72	− 69.47	28
.....	536,095	.....	− 359,927	.....	− 40.17	29
.....	97,442	.....	− 6,964	.....	− 6.67	30
.....	31,420	.....	− 321	.....	− 1.01	31
.....	217,284	.....	− 46,904	.....	− 17.75	32
10,569	39,287	+ 2,457	+ 5,469	+ 30.29	+ 16.17	33
.....	[k]	.....	.....	.....	.....	34
25,000	975,000	− 27,850	− 146,520	− 52.70	− 13.06	35
1,055,636	102,344	− 323,860	− 92,937	− 23.48	− 47.59	36
38,795	225,998	− 10,691	− 61,284	− 21.60	− 21.33	37
1,721,829	4,138,560	− 29,919	− 803,704	− 1.71	− 16.26	39
203	1,550	− 327	− 9,450	− 61.70	− 85.91	38
8,469	4,330	− 5,622	− 4,099	− 39.90	− 48.63	40
2,386,138	11,399,124	+ 120,795	+ 745,566	+ 5.33	+ 7.00	41
222,598	857,113	− 24,789	+ 62,164	− 10.02	+ 7.82	42
369,444	6,668,215	+ 76,338	+ 1,525,365	+ 26.04	+ 29.66	43
28,822,062	7,553,632	− 882,066	− 54,691	− 2.97	− .72	44
38,527	120,442	− 51,094	− 171,335	− 57.01	− 58.72	45
.....	[k]	.....	.....	.....	.....	46
68,694	2,410,367	− 3,279	− 568,791	− 4.56	− 19.09	47
56,292	5,072,460	− 15,492	− 1,418,200	− 21.58	− 21.85	48
936	19,624	+ 283	+ 7,725	+ 43.34	+ 64.92	49
135,382	1,888,881	− 38,479	− 937,608	− 17.19	− 33.17	50
52,167	263,968	− 45,609	− 216,362	− 46.65	− 45.04	51
359	7,230	+ 69	+ 1,590	+ 23.79	+ 28.19	52
67,240	400,918	− 17,309	− 98,151	− 20.47	− 19.67	53

[l] Nineteen short tons of high-grade concentrates shipped to England from South Carolina in 1903. In 1904 about 142 short tons of concentrates from South Carolina, South Dakota, and Alaska shipped to England. In 1905 no production. In 1906, 2,500 pounds of metallic tin, 55 short tons of concentrates from Alaska, and 14 short tons of concentrates from North Carolina and South Carolina. In 1907, about 89 short tons of concentrates. In 1908, no production.

[m] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania. Coke—1902: 25,401,730 short tons; value at ovens, $63,339,167. 1903: 25,274,281 short tons; value at ovens, $66,498,664. 1904: 23,661,106 short tons; value at ovens, $46,144,941. 1905: 32,231,129 short tons; value at ovens, $72,476,196. 1906: 36,401,217 short tons; value at ovens, $91,608,034. 1907: 40,779,564 short tons; value at ovens, $111,539,126. 1908: 26,033,518 short tons; value at ovens, $62,483,983.

[n] Of 42 gallons.

[o] Value of clay mined and sold as unmanufactured clay—1899: Census returns, $1,645,328. 1900: $1,840,377. 1901: $2,576,932. 1902: $2,061,072. 1903: $2,594,042. 1904: $2,320,162. 1905: $2,768,006. 1906: $3,245,256. 1907: $3,448,548. 1908: $2,599,986.

[p] Of 380 pounds net.

[q] Includes limestone for iron flux, but not grindstones.

[r] Of 280 pounds net. Value is for net product exclusive of cost of packages.

[s] Includes metallic paint, ocher, umber, mortar colors, sienna, ground slate, shales, sublimed blue lead, sublimed white lead, and zinc-lead.

Mineral products of the United

	Product.		1907.	
			Quantity.	Value.
	NONMETALLIC (SPOT VALUES)—continued.			
54	Fibrous talc	short tons	67,800	$626,000
55	Fuller's earth	do	32,851	291,773
56	Glass sand	do	1,187,296	1,250,067
57	Graphite (crystalline)	pounds	4,947,840	171,149
	Graphite (amorphous)	short tons	26,803	125,821
58	Magnesite	do	7,561	22,683
59	Manganese ores	long tons	5,604	63,369
	Manganiferous ores	do	103,844	259,473
60	Mica (sheet)	pounds	1,060,182	349,311
	Mica (scrap)	short tons	3,025	42,800
61	Mineral waters	gallons sold	52,060,520	7,331,503
62	Monazite and zircon	pounds	548,152	65,800
63	Precious stones			[a] 735,800
64	Quartz	short tons	22,977	157,094
65	Rutile			[b]
66	Sand (molding, building, etc.) and gravel	short tons	40,664,622	13,242,002
67	Talc and soapstone	do	72,010	905,047
68	Tungsten	do	1,640	890,048
69	Uranium and vanadium	do		[b]
70	Total value of nonmetallic mineral products			1,167,705,720
71	Total value of metallic products			903,802,244
72	Estimated value of mineral products unspecified [c]			100,000
73	Grand total			2,071,607,964

[a] Includes pearls valued at $264,500 in 1907.
[b] Included under unspecified.

States in 1907 and 1908—Continued.

1908.		Increase (+) or decrease (−) in 1908.		Percentage of increase (+) or decrease (−) in 1908.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
70,739	$697,390	+ 2,939	+ $71,390	+ 4.33	+ 11.40	54
29,714	278,367	− 3,137	− 13,406	− 9.55	− 4.59	55
1,093,553	1,134,599	− 93,743	− 115,468	− 7.90	− 9.24	56
2,288,000	132,840	−2,659,840	− 38,309	−53.76	− 22.38	57
1,443	75,250	− 25,360	− 50,571	−94.62	− 40.19	57
6,587	19,761	− 974	− 2,922	−12.88	− 12.88	58
6,144	62,779	+ 540	− 590	+ 9.64	− .93	59
55,620	132,556	− 48,224	− 126,917	−46.44	− 48.91	59
972,964	234,021	− 87,218	− 115,290	− 8.23	− 33.00	60
2,417	33,904	− 608	− 8,896	−20.10	− 20.79	60
56,108,820	7,287,269	+4,048,300	− 44,234	+ 7.78	− .60	61
422,646	50,718	− 125,506	− 15,082	−22.90	− 22.92	62
.....	415,063	.....	− 320,737	.....	− 43.59	63
38,825	138,646	+ 15,848	− 18,448	+68.97	− 11.74	64
.....	.....	.....	.....	.....	.....	65
36,122,491	12,135,433	−4,542,131	− 1,106,569	−11.17	− 8.36	66
46,615	703,832	− 25,395	− 201,215	−35.27	− 22.23	67
671	229,955	− 969	− 660,093	−59.09	− 74.16	68
.....	.....	.....	.....	.....	.....	69
.....	1,045,497,070	.....	−122,208,650	.....	− 10.47	70
.....	549,923,116	.....	−353,879,128	.....	− 39.15	71
.....	250,000	.....	+ 150,000	.....	+150.00	72
.....	1,595,670,186	.....	−475,937,778	.....	− 22.97	73

[c] Includes, in 1907: Nitrate of soda, carbonate of soda, sulphate of soda, and alum clays used by paper manufacturers; and molybdenum, nickel and cobalt, tantalum, titanium, uranium, and vanadium, valued together at $31,945. In 1908: Nitrate of soda, carbonate of soda, sulphate of soda, and alum clays used by paper manufacturers; nickel and cobalt, cadmium, arsenic, and bismuth, valued together at $169,281.

Mineral products of the United States

	Product.	1880.	
		Quantity.	Value.
	METALLIC.		
1	Pig iron, value at Philadelphia ..... long tons..	3,375,912	$89,315,569
2	Silver, commercial value ..... troy ounces..	30,318,700	34,717,000
3	Gold, coining value ..... do....	1,741,500	36,000,000
4	Copper, value at New York City ..... pounds..	60,480,000	11,491,200
5	Lead, value at New York City ..... short tons..	97,825	9,782,500
6	Zinc, value at New York City ..... do....	23,239	2,277,432
7	Quicksilver, value at San Francisco ..... flasks..	59,926	1,797,780
8	Nickel, value at Philadelphia ..... pounds..	233,893	257,282
9	Aluminum, value at Pittsburg ..... do....	.....	.....
10	Antimony, value at San Francisco ..... short tons..	50	10,000
11	Platinum (crude) value at San Francisco ..... troy ounces..	100	400
12	Total value of metallic products	.....	185,649,163
	NONMETALLIC (SPOT VALUES).		
13	Bituminous coal ..... short tons..	38,242,641	53,443,718
14	Pennsylvania anthracite ..... long tons..	25,580,189	42,196,678
15	Stone	.....	18,356,055
16	Petroleum ..... barrels..	26,286,123	24,183,233
17	Lime ..... do....	28,000,000	19,000,000
18	Natural gas	.....	.....
19	Cement ..... barrels..	2,072,943	1,852,707
20	Salt ..... do....	5,961,060	4,829,566
21	Phosphate rock ..... long tons..	211,377	1,123,823
22	Limestone for iron flux ..... do....	4,500,000	3,800,000
23	Mineral waters ..... gallons sold..	2,000,000	500,000
24	Zinc white ..... short tons..	10,107	763,738
25	Potters' clay ..... do....	28,877	200,457
26	Mineral paints ..... do....	3,604	135,840
27	Borax ..... pounds..	3,692,443	277,233
28	Gypsum ..... short tons..	90,000	400,000
29	Grindstones	.....	500,000
30	Fibrous talc ..... short tons..	4,210	54,730
31	Pyrite ..... long tons..	2,000	5,000
32	Soapstone ..... short tons..	8,441	66,665
33	Manganese ores ..... long tons..	5,761	86,415
34	Asphalt ..... short tons..	444	4,440
35	Precious stones	.....	100,000
36	Bromine ..... pounds..	404,690	114,752
37	Corundum ..... short tons..	1,044	29,280
38	Barytes (crude) ..... do....	20,000	80,000
39	Graphite ..... pounds..	.....	49,800
40	Millstones	.....	200,000
41	Oilstones, etc.[a] ..... pounds..	420,000	8,000
42	Marls ..... short tons..	1,000,000	500,000
43	Flint ..... long tons..	20,000	80,000
44	Fluorspar ..... short tons..	4,000	16,000
45	Chromic iron ore ..... long tons..	2,288	27,808
46	Infusorial earth ..... short tons..	1,833	45,660
47	Feldspar ..... long tons..	12,500	60,000
48	Mica ..... pounds..	81,669	127,825
49	Cobalt oxide ..... do....	7,251	24,000
50	Slate ground as a pigment ..... short tons..	1,000	10,000
51	Sulphur ..... do....	600	21,000
52	Asbestos ..... do....	150	4,312
53	Rutile ..... pounds..	100	400
54	Lithographic stone ..... short tons..	.....	.....
55	Total value of nonmetallic mineral products	.....	173,279,135
56	Total value of metallic products	.....	185,649,163
57	Estimated value of mineral products unspecified	.....	6,000,000
58	Grand total	.....	364,928,298

[a] Prior to 1889 quantity and value are for rough stone quarried; since 1890 they are for finished product.

for the calendar years 1880–1908.

1881.		1882.		1883.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
4,144,254	$87,029,334	4,623,323	$106,336,429	4,595,510	$91,910,200	1
33,257,800	37,657,500	36,196,900	41,105,900	35,732,800	39,618,400	2
1,678,612	34,700,000	1,572,187	32,500,000	1,451,250	30,000,000	3
71,680,000	12,175,600	91,646,232	16,038,091	117,151,795	18,064,807	4
117,085	11,240,160	132,890	12,624,550	143,957	12,322,719	5
26,800	2,680,000	33,765	3,646,620	36,872	3,311,106	6
60,851	1,764,679	52,732	1,487,042	46,725	1,253,632	7
265,668	292,235	281,616	309,777	58,800	52,920	8
.....	.....	.....	.....	83	875	9
50	10,000	60	12,000	60	12,000	10
100	400	200	600	200	600	11
.....	187,549,908	.....	214,061,009	.....	196,547,259	12
48,179,475	60,224,344	60,861,190	76,076,487	68,531,500	82,237,800	13
28,500,016	64,125,036	31,358,264	70,556,094	34,336,469	77,257,055	14
.....	20,000,000	.....	21,000,000	.....	20,000,000	15
27,661,238	25,448,339	30,510,830	24,065,988	23,449,633	25,790,252	16
30,000,000	20,000,000	31,000,000	21,700,000	32,000,000	19,200,000	17
.....	.....	.....	215,000	.....	475,000	18
2,500,000	2,000,000	3,250,000	3,672,750	4,190,000	4,293,500	19
6,200,000	4,200,000	6,412,373	4,320,140	6,192,231	4,211,042	20
266,734	1,980,259	332,077	1,992,462	378,380	2,270,280	21
6,000,000	4,100,000	3,850,000	2,310,000	3,814,273	1,907,136	22
3,700,000	700,000	5,000,000	800,000	7,529,423	1,119,603	23
10,000	700,000	10,000	700,000	12,000	840,000	24
28,000	200,000	33,600	240,000	35,840	250,000	25
6,000	100,000	7,000	105,000	7,000	84,000	26
4,046,000	304,461	4,236,291	338,903	6,500,000	585,000	27
85,000	350,000	100,000	450,000	90,000	420,000	28
.....	500,000	.....	700,000	.....	600,000	29
5,000	60,000	6,000	75,000	6,000	75,000	30
10,000	60,000	12,000	72,000	25,000	137,500	31
7,000	75,000	6,000	90,000	8,000	150,000	32
4,895	73,425	4,532	67,980	6,155	92,325	33
2,000	8,000	3,000	10,500	3,000	10,500	34
.....	110,000	.....	150,000	.....	207,050	35
300,000	75,000	250,000	75,000	301,100	72,264	36
500	80,000	500	80,000	550	100,000	37
20,000	80,000	20,000	80,000	27,000	108,000	38
400,000	30,000	425,000	34,000	575,000	46,000	39
.....	150,000	.....	200,000	.....	150,000	40
500,000	8,580	600,000	10,000	600,000	10,000	41
1,000,000	500,000	1,080,000	540,000	972,000	486,000	42
25,000	100,000	25,000	100,000	25,000	100,000	43
4,000	16,000	4,000	20,000	4,000	20,000	44
2,000	30,000	2,500	50,000	3,000	60,000	45
1,000	10,000	1,000	8,000	1,000	5,000	46
14,000	70,000	14,000	70,000	14,100	71,112	47
100,000	250,000	100,000	250,000	114,000	285,000	48
8,280	25,000	11,653	32,046	1,096	2,795	49
1,000	10,000	2,000	24,000	2,000	24,000	50
600	21,000	600	21,000	1,000	27,000	51
200	7,000	1,200	36,000	1,000	30,000	52
200	700	500	1,800	550	2,000	53
50	1,000	.....	.....	.....	.....	54
.....	206,783,144	.....	231,340,150	.....	243,812,214	55
.....	187,549,908	.....	214,061,009	.....	196,947,259	56
.....	6,500,000	.....	6,500,000	.....	6,500,000	57
.....	400,833,052	.....	451,901,159	.....	446,859,473	58

Mineral products of the United States for

	Product.	1884.	
		Quantity.	Value.
	METALLIC.		
1	Pig iron, value at Philadelphia ..... long tons..	4,097,868	$73,761,624
2	Silver, commercial value ..... troy ounces..	37,743,800	41,921,300
3	Gold, coining value ..... do....	1,489,950	36,800,000
4	Copper, value at New York City ..... pounds..	145,221,934	17,789,687
5	Lead, value at New York City ..... short tons..	139,897	10,537,042
6	Zinc, value at New York City ..... do....	38,544	3,422,707
7	Quicksilver, value at San Francisco ..... flasks..	31,913	936,327
8	Nickel, value at Philadelphia ..... pounds..	64,550	48,412
9	Aluminum, value at Pittsburg ..... do....	150	1,350
10	Antimony, value at San Francisco ..... short tons..	60	12,000
11	Platinum (crude), value at San Francisco ..... troy ounces..	150	450
12	Total value of metallic products	.....	179,230,899
	NONMETALLIC (SPOT VALUES).		
13	Bituminous coal ..... short tons..	73,730,539	77,417,066
14	Pennsylvania anthracite ..... long tons..	33,175,756	66,351,512
15	Stone	.....	19,000,000
16	Petroleum ..... barrels..	24,218,438	20,595,966
17	Lime ..... do....	37,000,000	18,500,000
18	Natural gas	.....	1,460,000
19	Brick clay	.....	.....
20	Clay (all other than brick) ..... short tons..	39,200	270,000
21	Cement ..... barrels..	4,000,000	3,720,000
22	Salt ..... do....	6,514,937	4,197,734
23	Phosphate rock ..... long tons..	431,779	2,374,784
24	Limestone for iron flux ..... do....	3,401,930	1,700,965
25	Mineral waters ..... gallons sold..	10,215,328	1,459,143
26	Zinc white ..... short tons..	13,000	910,000
27	Mineral paints ..... do....	7,000	84,000
28	Borax ..... pounds..	7,000,000	490,000
29	Gypsum ..... short tons..	90,000	390,000
30	Grindstones	.....	570,000
31	Fibrous talc ..... short tons..	10,000	110,000
32	Pyrite ..... long tons..	35,000	175,000
33	Soapstone ..... short tons..	10,000	200,000
34	Manganese ores ..... long tons..	10,180	122,160
35	Asphalt ..... short tons..	3,000	10,500
36	Precious stones	.....	222,975
37	Bromine ..... pounds..	281,100	67,464
38	Corundum ..... short tons..	600	108,000
39	Barytes (crude) ..... do....	25,000	100,000
40	Graphite ..... pounds..	.....	.....
41	Millstones	.....	150,000
42	Oilstones, etc.[a] ..... pounds..	800,000	12,000
43	Marls ..... short tons..	875,000	437,500
44	Flint ..... long tons..	30,000	120,000
45	Fluorspar ..... short tons..	4,000	20,000
46	Chromic iron ore ..... long tons..	2,000	35,000
47	Infusorial earth ..... short tons..	1,000	5,000
48	Feldspar ..... long tons..	10,900	55,112
49	Mica ..... pounds..	147,410	368,525
50	Colbalt oxide ..... do....	2,000	5,100
51	Slate ground as a pigment ..... short tons..	2,000	20,000
52	Sulphur ..... do....	500	12,000
53	Asbestos ..... do....	1,000	30,000
54	Rutile ..... pounds..	600	2,000
55	Lithographic stone ..... short tons..	.....	.....
56	Total value of nonmetallic mineral products	.....	221,879,506
57	Total value of metallic products	.....	179,230,899
58	Estimated value of mineral products unspecified	.....	5,000,000
59	Grand total	.....	406,110,405

[a] Prior to 1889 quantity and value are for rough stone quarried; since 1890 they are for finished product.

the calendar years 1880–1908—Continued.

1885.		1886.		1887.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
4,044,425	$64,712,400	5,683,329	$95,195,760	6,417,148	$121,925,800	1
39,909,400	42,503,500	39,694,000	39,482,400	41,721,600	40,887,200	2
1,538,373	31,801,000	1,686,788	34,869,000	1,603,049	33,136,000	3
170,962,607	18,292,999	161,235,381	16,527,651	185,227,331	21,115,916	4
129,412	10,469,431	130,629	12,200,749	145,700	13,113,000	5
40,688	3,539,856	42,641	3,752,408	50,340	4,782,300	6
32,073	979,189	29,981	1,060,000	33,825	1,429,000	7
277,904	179,975	214,992	127,157	205,566	133,200	8
283	2,550	3,000	27,000	18,000	59,000	9
50	10,000	35	7,000	75	15,000	10
250	187	50	100	448	1,838	11
.....	172,491,087	.....	203,249,225	.....	236,598,254	12
64,840,668	82,347,648	73,707,957	78,481,056	87,887,360	98,004,656	13
34,228,548	76,671,948	34,853,077	76,119,120	37,578,747	84,552,181	14
.....	19,000,000	.....	19,000,000	.....	25,000,000	15
21,847,205	19,198,243	28,064,841	19,996,313	28,278,866	18,877,094	16
40,000,000	20,000,000	.....	.....	.....	.....	17
.....	4,857,200	.....	10,012,000	.....	15,817,500	18
.....	.....	.....	6,200,000	.....	7,000,000	19
40,320	275,000	44,800	325,000	48,160	340,000	20
4,150,000	3,492,500	4,500,000	3,990,000	6,692,744	5,674,377	21
7,038,653	4,825,345	7,707,081	4,736,585	7,831,962	4,093,846	22
437,856	2,846,064	430,549	1,872,936	480,558	1,836,818	23
3,356,956	1,678,478	4,717,163	2,830,297	5,377,000	3,226,200	24
9,148,401	1,312,845	8,950,317	1,284,070	8,259,609	1,261,463	25
15,000	1,050,000	18,000	1,440,000	18,000	1,440,000	26
3,950	43,575	18,800	315,000	22,000	330,000	27
8,000,000	480,000	9,778,290	488,915	11,000,000	550,000	28
90,405	405,000	95,250	428,625	95,000	425,000	29
.....	500,000	.....	250,000	.....	224,400	30
10,000	110,000	12,000	125,000	15,000	160,000	31
49,000	220,500	55,000	220,000	52,000	210,000	32
10,000	200,000	12,000	225,000	12,000	225,000	33
23,258	190,281	30,193	277,636	34,524	333,844	34
3,000	10,500	3,500	14,000	4,000	16,000	35
.....	209,200	.....	119,056	.....	163,600	36
310,000	89,900	428,334	141,350	199,087	61,717	37
600	108,000	645	116,190	600	108,000	38
15,000	75,000	10,000	50,000	15,000	75,000	39
327,883	26,231	415,525	33,242	416,000	34,000	40
.....	100,000	.....	140,000	.....	100,000	41
1,000,000	15,000	1,160,000	15,000	1,200,000	16,000	42
875,000	437,500	800,000	400,000	600,000	300,000	43
30,000	120,000	30,000	120,000	32,000	128,000	44
5,000	22,500	5,000	22,000	5,000	20,000	45
2,700	40,000	2,000	30,000	3,000	40,000	46
1,000	5,000	1,200	6,000	3,000	15,000	47
13,600	68,000	14,900	74,500	10,200	61,200	48
92,000	161,000	40,000	70,000	70,000	142,250	49
68,723	65,373	35,000	36,878	18,340	18,774	50
1,975	24,687	.....	.....	.....	.....	51
715	17,875	2,500	75,000	3,000	100,000	52
300	9,000	200	6,000	150	4,500	53
600	2,000	600	2,000	1,000	3,000	54
.....	.....	.....	.....	.....	.....	55
.....	241,312,093	.....	230,088,769	.....	270,989,420	56
.....	172,491,087	.....	203,249,225	.....	236,598,264	57
.....	5,000,000	.....	800,000	.....	800,000	58
.....	418,803,180	.....	434,137,994	.....	508,387 674	59

Mineral products of the United States for

	Product.		1888.	
			Quantity.	Value.
	METALLIC.			
1	Pig iron, value at Philadelphia	long tons..	6,489,738	$107,000,000
2	Silver, commercial value	troy ounces..	45,792,700	43,045,100
3	Gold, coining value	do....	1,604,478	33,167,500
4	Copper, value at New York City	pounds..	231,270,622	33,833,954
5	Lead, value at New York City	short tons..	151,919	13,399,256
6	Zinc, value at New York City	do....	55,903	5,500,855
7	Quicksilver, value at San Francisco	flasks..	33,250	1,413,125
8	Aluminum, value at Pittsburg	pounds..	19,000	65,000
9	Antimony, value at San Francisco	short tons..	100	20,000
10	Nickel, value at Philadelphia	pounds..	204,328	127,632
11	Tin	do....	.....	.....
12	Platinum (crude), value at San Francisco	troy ounces..	500	2,000
13	Total value of metallic products		.....	237,574,422
	NONMETALLIC (SPOT VALUES).			
14	Bituminous coal	short tons..	102,039,838	101,860,529
15	Pennsylvania anthracite	long tons..	41,624,611	89,020,483
16	Stone		.....	25,500,000
17	Petroleum	barrels..	27,612,025	17,947,620
18	Natural gas		.....	22,629,875
19	Brick clay		.....	7,500,000
20	Clay (all other than brick)	short tons..	41,160	300,000
21	Cement	barrels..	6,503,295	5,021,139
22	Mineral waters	gallons sold..	9,578,648	1,679,302
23	Phosphate rock	long tons..	448,567	2,018,552
24	Salt	barrels..	8,055,881	4,374,203
25	Limestone for iron flux	long tons..	5,438,000	2,719,000
26	Zinc white	short tons..	20,000	1,600,000
27	Gypsum	do....	110,000	550,000
28	Borax	pounds..	7,589,000	455,340
29	Mineral paints	short tons..	26,500	405,000
30	Grindstones		.....	281,800
31	Fibrous talc	short tons..	20,000	210,000
32	Asphalt	do....	53,800	331,500
33	Soapstone	do....	15,000	250,000
34	Precious stones		.....	139,850
35	Pyrite	long tons..	54,331	167,658
36	Corundum	short tons..	589	91,620
37	Oilstones, etc.[a]	pounds..	1,500,000	18,000
38	Mica	do....	48,000	70,000
39	Barytes (crude)	short tons..	20,000	110,000
40	Bromine	pounds..	307,386	95,290
41	Fluorspar	short tons..	6,000	30,000
42	Feldspar	long tons..	8,700	50,000
43	Manganese ores	do....	29,198	279,571
44	Flint	do....	30,000	127,500
45	Graphite	pounds..	400,000	33,000
46	Bauxite	long tons..	.....	.....
47	Sulphur	short tons..	.....	.....
48	Marls	do....	300,000	150,000
49	Infusorial earth	do....	1,500	7,500
50	Millstones		.....	81,000
51	Chromic iron ore	long tons..	1,500	20,000
52	Cobalt oxide	pounds..	8,491	15,782
53	Magnesite	short tons..	.....	.....
54	Asbestos	do....	100	3,000
55	Rutile	pounds..	1,000	3,000
56	Ozokerite (refined)	do....	43,500	3,000
57	Total value of nonmetallic mineral products		.....	286,150,114
58	Total value of metallic products		.....	237,574,422
59	Estimated value of mineral products unspecified		.....	900,000
60	Grand total		.....	524,624,536

[a] Prior to 1889 quantity and value are for rough stone quarried; since 1890 they are for finished product.

the calendar years 1880–1908—Continued.

1889.		1890.		1891.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
7,603,642	$120,000,000	9,202,703	$151,200,410	8,279,870	$128,387,985	1
50,094,500	46,938,400	54,516,300	57,242,100	58,330,000	57,630,000	2
1,594,775	32,967,000	1,588,877	32,845,000	1,604,840	33,175,000	3
231,246,214	26,907,809	265,115,133	30,848,797	295,812,076	38,455,300	4
156,397	13,794,235	143,630	12,668,166	178,554	15,534,198	5
58,860	5,791,824	63,685	6,266,407	80,873	8,033,700	6
26,484	1,190,500	22,926	1,203,615	22,904	1,036,386	7
47,468	97,335	61,281	61,281	150,000	100,000	8
115	28,000	938	177,508	1,289	217,957	9
252,663	151,598	223,488	134,093	118,498	71,099	10
.....	.....	.....	.....	125,289	25,058	11
500	2,000	600	2,500	100	500	12
.....	247,768,701	.....	292,649,877	.....	282,617,183	13
95,685,543	94,504,745	111,320,016	110,420,801	117,901,237	117,188,400	14
40,714,721	65,879,514	41,489,858	66,383,772	45,236,992	73,944,735	15
.....	42,809,706	.....	47,000,000	.....	47,294,746	16
35,163,513	26,963,340	45,822,672	35,365,105	54,291,980	30,526,553	17
.....	21,097,099	.....	18,792,725	.....	15,500,084	18
.....	8,000,000	.....	8,500,000	.....	9,000,000	19
329,665	635,578	392,000	756,000	448,000	900,000	20
7,000,000	5,000,000	8,000,000	6,000,000	8,222,792	6,680,951	21
12,780,471	1,748,458	13,907,418	2,600,750	18,392,732	2,996,259	22
550,245	2,937,776	510,499	3,213,795	587,988	3,651,150	23
8,005,565	4,195,412	8,776,991	4,752,286	9,987,945	4,716,121	24
6,318,000	3,159,000	5,521,622	2,760,811	5,000,000	2,300,000	25
16,970	1,357,600	.....	1,600,000	23,700	1,600,000	26
267,769	764,118	182,995	574,523	208,126	628,051	27
8,000,000	500,000	9,500,000	617,500	13,380,000	869,700	28
34,307	483,766	47,732	681,992	49,652	678,478	29
.....	439,587	.....	450,000	.....	476,113	30
23,746	244,170	41,354	389,196	53,054	493,068	31
51,735	171,537	40,841	190,416	45,054	242,264	32
12,715	231,708	13,670	252,309	16,514	243,981	33
.....	188,807	.....	118,833	.....	235,300	34
93,705	202,119	99,854	273,745	106,536	338,880	35
2,245	105,565	1,970	89,395	2,265	90,230	36
5,982,000	32,980	.....	69,909	1,375,000	150,000	37
49,500	50,000	60,000	75,000	75,000	100,000	38
19,161	106,313	21,911	86,505	31,069	118,363	39
418,891	125,667	387,847	104,719	343,000	54,880	40
9,500	45,835	8,250	55,328	10,044	78,330	41
6,970	39,370	8,000	45,200	10,000	50,000	42
24,197	240,559	25,684	219,050	23,416	239,129	43
21,113	89,730	13,000	57,400	15,000	60,000	44
.....	72,662	.....	77,500	.....	110,000	45
728	2,366	1,844	6,012	3,593	11,675	46
1,150	7,850	.....	.....	1,200	39,600	47
139,522	63,956	153,620	69,880	135,000	67,500	48
3,466	23,372	2,532	50,240	.....	21,988	49
.....	35,155	.....	23,720	.....	16,587	50
2,000	30,000	3,599	53,985	1,372	20,580	51
13,955	31,092	6,788	16,291	7,200	18,000	52
.....	.....	.....	.....	439	4,390	53
30	1,800	71	4,560	66	3,390	54
1,000	3,000	400	1,000	300	800	55
50,000	2,500	350,000	26,250	50,000	7,000	56
.....	282,673,812	.....	312,826,503	.....	321,767,846	57
.....	247,768,701	.....	292,649,877	.....	282,617,183	58
.....	1,000,000	.....	1,000,000	.....	1,000,000	59
.....	531,392,513	.....	606,476,380	.....	605,385,029	60

Mineral products of the United States for

	Product.	1892.	
		Quantity.	Value.
	METALLIC.		
1	Pig iron, spot value.....long tons..	9,157,000	$131,161,039
2	Silver, commercial value.....troy ounces..	63,500,000	55,662,500
3	Gold, coining value.....do....	1,597,098	33,015,000
4	Copper, value at New York City.....pounds..	352,971,744	37,977,142
5	Lead, value at New York City.....short tons..	173,654	13,892,320
6	Zinc, value at New York City.....do....	87,260	8,027,920
7	Quicksilver, value at San Francisco.....flasks..	27,993	1,245,689
8	Aluminum, value at Pittsburg.....pounds..	259,885	172,824
9	Antimony, value at San Francisco.....short tons..	1,790	276,416
10	Nickel, value at Philadelphia.....pounds..	92,252	50,739
11	Tin.....do....	162,000	32,400
12	Platinum, value (crude) at San Francisco.....troy ounces..	80	550
13	Total value of metallic products.....	.....	281,514,539
	NONMETALLIC (SPOT VALUES).		
14	Bituminous coal.....short tons..	126,856,567	125,124,381
15	Pennsylvania anthracite.....long tons..	46,850,450	82,442,000
16	Natural gas.....	.....	14,870,714
17	Petroleum.....barrels..	50,509,136	26,034,196
18	Brick clay.....	.....	9,000,000
19	Cement.....barrels..	8,758,621	7,152,750
20	Stone.....	.....	48,706,625
21	Corundum and emery.....short tons..	1,771	181,300
22	Crystalline quartz.....do....	.....	.....
23	Garnet for abrasive purposes.....do....	.....	.....
24	Grindstones.....	.....	272,244
25	Infusorial earth and tripoli.....short tons..	.....	43,655
26	Millstones.....	.....	23,417
27	Oilstones, etc.....	.....	146,730
28	Borax.....pounds..	13,500,000	900,000
29	Bromine.....do....	379,480	64,502
30	Fluorspar.....short tons..	12,250	89,000
31	Gypsum.....do....	256,259	695,492
32	Marls.....do....	125,000	65,000
33	Phosphate rock.....long tons..	681,571	3,296,227
34	Pyrite.....do....	109,788	305,191
35	Salt.....barrels..	11,698,890	5,654,915
36	Sulphur.....short tons..	2,688	80,640
37	Barytes (crude).....do....	32,108	130,025
38	Cobalt oxide.....pounds..	7,869	15,738
39	Mineral paints.....short tons..	51,704	767,766
40	Zinc white.....do....	27,500	2,200,000
41	Asbestos.....do....	104	6,416
42	Asphalt.....do....	87,680	445,375
43	Bauxite.....long tons..	10,518	34,183
44	Chromic iron ore.....do....	1,500	25,000
45	Clay (all other than brick).....short tons..	470,400	1,000,000
46	Feldspar.....do....	16,800	75,000
47	Fibrous talc.....do....	41,925	472,485
48	Flint.....do....	22,400	80,000
49	Fuller's earth.....do....	.....	.....
50	Graphite.....pounds..	.....	104,000
51	Limestone for iron flux.....long tons..	5,172,114	3,620,480
52	Magnesite.....short tons..	1,004	10,040
53	Manganese ores.....long tons..	13,613	129,586
54	Mica.....pounds..	75,000	100,000
55	Mineral waters.....gallons sold..	21,876,604	4,905,970
56	Monazite.....pounds..	.....	.....
57	Ozokerite (refined).....do....	60,000	8,000
58	Precious stones.....	.....	312,050
59	Pumice stone.....short tons..	.....	.....
60	Rutile.....pounds..	100	300
61	Soapstone.....short tons..	23,908	437,449
62	Total value of nonmetallic mineral products.....	.....	340,028,842
63	Total value of metallic products.....	.....	281,514,539
64	Estimated value of mineral products unspecified.....	.....	1,000,000
65	Grand total.....	.....	622,543,381

[a] Including copper made from imported pyrites.

the calendar years 1880–1908—Continued.

1893.		1894.		1895.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
7,124,502	$84,810,426	6,657,388	$65,007,247	9,446,308	$105,198,550	1
60,000,000	46,800,000	49,500,000	31,422,100	55,727,000	36,445,500	2
1,739,323	35,955,000	1,910,813	39,500,000	2,254,760	46,610,000	3
339,785,972	32,054,601	364,866,808	33,141,142	[a] 385,913,404	38,012,470	4
163,982	11,839,590	159,331	9,942,254	170,000	11,220,000	5
78,832	6,306,560	75,328	5,288,026	89,686	6,278,020	6
30,164	1,108,527	30,416	934,000	36,104	1,337,131	7
339,629	266,903	550,060	316,250	920,000	464,600	8
1,503	270,540	1,387	249,706	2,013	304,169	9
49,399	22,197	9,616	3,269	10,302	3,091	10
8,938	1,788	.....	.....	.....	.....	11
75	517	100	600	150	900	12
.....	219,436,649	.....	185,804,594	.....	245,874,431	13
128,385,231	122,751,618	118,820,405	107,653,501	135,118,193	115,779,771	14
48,185,306	85,687,078	46,358,144	78,488,063	51,785,122	82,019,272	15
.....	14,346,250	.....	13,954,400	.....	13,006,650	16
48,412,666	28,932,326	49,344,516	35,522,095	52,892,276	57,632,296	17
.....	9,000,000	.....	[b] 64,655,388	.....	[b] 65,409,806	18
8,002,467	6,262,841	8,362,245	5,030,081	8,731,401	5,482,254	19
.....	33,885,573	.....	36,534,788	.....	33,319,131	20
1,713	142,325	1,495	95,936	2,102	106,256	21
.....	.....	6,024	18,054	9,000	27,000	22
.....	.....	.....	.....	3,325	95,050	23
.....	338,787	.....	223,214	.....	205,768	24
.....	22,582	2,584	11,718	4,954	20,514	25
.....	16,645	.....	13,887	.....	22,542	26
.....	135,173	.....	136,873	.....	155,881	27
8,699,000	652,425	14,680,130	974,445	11,918,000	595,900	28
348,399	104,520	379,444	102,450	517,421	134,343	29
12,400	84,000	7,500	47,500	4,000	24,000	30
253,615	696,615	239,312	761,719	265,503	797,447	31
75,000	40,000	75,000	40,000	60,000	30,000	32
941,368	4,136,070	996,949	3,479,547	1,038,551	3,606,094	33
75,777	256,552	105,940	363,134	99,549	322,845	34
11,816,772	4,054,668	12,967,417	4,739,285	13,669,649	4,423,084	35
1,200	42,000	500	20,000	1,800	42,000	36
28,970	88,506	23,335	86,983	21,529	68,321	37
8,422	10,346	6,763	10,145	14,458	20,675	38
37,724	530,384	41,926	498,093	50,695	621,552	39
24,059	1,804,420	19,987	1,399,090	20,710	1,449,700	40
50	2,500	325	4,463	795	13,525	41
47,779	372,232	60,570	353,400	68,163	348,281	42
9,079	29,507	11,066	35,818	17,069	44,000	43
1,450	21,750	3,680	53,231	1,740	16,795	44
448,000	900,000	.....	.....	.....	.....	45
20,578	68,307	19,264	167,000	8,523	30,000	46
35,861	403,436	39,906	435,060	39,240	370,897	47
33,231	63,792	42,560	319,200	13,747	21,038	48
.....	.....	.....	.....	6,900	41,400	49
843,103	63,232	918,000	64,010	.....	52,582	50
3,958,055	2,374,833	3,698,550	1,849,275	5,247,949	2,623,974	51
704	7,040	1,440	10,240	2,220	17,000	52
7,718	66,614	6,308	53,635	9,547	71,769	53
66,971	88,929	.....	52,388	.....	55,831	54
23,544,495	4,246,734	21,569,608	3,741,846	21,463,543	4,254,237	55
130,000	7,600	546,855	36,193	1,573,000	137,150	56
.....	.....	.....	.....	.....	.....	57
.....	264,041	.....	132,250	.....	113,621	58
.....	.....	.....	.....	.....	.....	59
.....	.....	150	450	100	350	60
21,071	255,067	23,144	401,325	21,495	266,495	61
.....	323,257,318	.....	362,570,173	.....	393,897,097	62
.....	219,436,649	.....	185,804,594	.....	245,874,431	63
.....	1,000,000	.....	1,000,000	.....	1,000,000	64
.....	543,693,967	.....	549,374,767	.....	640,771,528	65

[b] Clay products.

Mineral products of the United States for

	Product.	1896.	
		Quantity.	Value.
	METALLIC.		
1	Pig iron, spot value ..... long tons	8,623,127	$90,250,000
2	Silver, commercial value ..... troy ounces	58,834,800	39,654,600
3	Gold, coining value ..... do	2,568,132	53,088,000
4	Copper, value at New York City ..... pounds	460,061,430	49,456,603
5	Lead, value at New York City ..... short tons	188,000	10,528,000
6	Zinc, value at New York City ..... do	81,499	6,519,920
7	Quicksilver, value at San Francisco ..... flasks	30,765	1,075,449
8	Aluminum, value at Pittsburg ..... pounds	1,300,000	520,000
9	Antimony, value at San Francisco ..... short tons	2,478	347,539
10	Nickel, value at Philadelphia ..... pounds	17,170	4,464
11	Tin ..... do	.....	.....
12	Platinum, value (crude) at New York City ..... troy ounces	163	944
13	Total value of metallic products	.....	251,445,519
	NONMETALLIC (SPOT VALUES).		
14	Bituminous coal ..... short tons	137,640,276	114,891,515
15	Pennsylvania anthracite ..... long tons	48,523,287	81,748,651
16	Natural gas	.....	13,002,512
17	Petroleum ..... barrels	60,960,361	58,518,709
18	Clay products	.....	63,110,408
19	Cement ..... barrels	9,513,473	6,473,213
20	Lime	.....	6,327,900
21	Slate	.....	2,746,205
22	Stone	.....	23,965,229
23	Corundum and emery ..... short tons	2,120	113,246
24	Crystalline quartz ..... do	6,000	18,000
25	Garnet for abrasive purposes ..... do	2,686	68,877
26	Grindstones	.....	326,826
27	Infusorial earth and tripoli ..... short tons	3,846	26,792
28	Millstones	.....	22,567
29	Oilstones, etc	.....	127,098
30	Borax ..... pounds	13,508,000	675,400
31	Bromine ..... do	546,580	144,501
32	Fluorspar ..... short tons	6,500	52,000
33	Gypsum ..... do	224,254	573,344
34	Marls ..... do	60,000	30,000
35	Phosphate rock ..... long tons	930,779	2,803,372
36	Pyrite ..... do	115,483	320,163
37	Salt ..... barrels	13,850,726	4,040,839
38	Sulphur ..... short tons	5,260	87,200
39	Barytes (crude) ..... do	17,068	46,513
40	Cobalt oxide ..... pounds	10,700	15,301
41	Mineral paints ..... short tons	43,894	459,089
42	Zinc white ..... do	20,000	1,400,000
43	Asbestos ..... do	504	6,100
44	Asphalt ..... do	80,503	577,563
45	Bauxite ..... long tons	18,364	47,338
46	Chromic iron ore ..... do	786	6,667
47	Feldspar ..... short tons	10,203	35,200
48	Fibrous talc ..... do	46,089	399,443
49	Fuller's earth ..... do	9,872	59,360
50	Graphite (crystalline) ..... pounds	535,858	48,460
51	Graphite (amorphous) ..... short tons	760	
52	Magnesite ..... do	1,500	11,000
53	Manganese ores ..... long tons	10,088	90,727
54	Mica (sheet) ..... pounds	49,156	65,441
55	Mica (scrap) ..... short tons	222	1,750
56	Mineral waters ..... gallons sold	25,795,312	4,136,192
57	Monazite ..... pounds	30,000	1,500
58	Ozokerite (refined) ..... do	.....	.....
59	Precious stones	.....	97,850
60	Pumice stone ..... short tons	.....	.....
61	Quartz (flint) ..... do	12,458	24,226
62	Rutile ..... pounds	100	350
63	Soapstone ..... short tons	22,183	354,065
64	Total value of nonmetallic mineral products	.....	388,098,702
65	Total value of metallic products	.....	251,445,519
66	Estimated value of mineral products unspecified	.....	1,000,000
67	Grand total	.....	640,544,221

the calendar years 1880–1908—Continued.

1897.		1898.		1899.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
9,652,680	$95,122,299	11,773,934	$116,557,000	13,620,703	$245,172,654	1
53,860,000	32,316,000	54,438,000	32,118,400	54,764,500	32,858,700	2
2,774,935	57,363,000	3,118,398	64,463,000	3,437,210	71,053,400	3
494,078,274	54,080,180	526,512,987	61,865,276	568,666,921	101,222,712	4
212,000	14,885,728	222,000	16,650,000	210,500	18,945,000	5
99,980	8,498,300	115,399	10,385,910	129,051	14,840,865	6
26,648	993,445	31,092	1,188,627	30,454	1,452,745	7
4,000,000	1,500,000	5,200,000	1,716,000	6,500,000	1,716,000	8
3,061	442,300	3,238	532,101	2,861	559,189	9
23,707	7,823	11,145	3,956	22,541	8,566	10
						11
150	900	225	1,913	300	1,800	12
	265,209,975		305,482,183		487,831,631	13
147,617,519	119,595,224	166,593,623	132,608,713	193,323,187	167,952,104	14
46,974,714	79,301,954	47,663,076	75,414,537	53,944,647	88,142,130	15
	13,826,422		15,296,813		20,074,873	16
60,475,516	40,874,072	55,364,233	44,193,359	57,070,850	64,603,904	17
	62,359,991		74,487,680		95,797,370	18
10,989,463	8,178,283	12,111,208	9,859,501	15,520,445	12,889,142	19
	6,390,487		6,886,549		6,983,067	20
	3,524,614		3,723,540		3,962,733	21
	26,876,671		28,635,175		35,244,717	22
2,165	106,574	4,064	275,064	4,900	150,600	23
7,500	22,500	8,312	23,990	13,600	39,000	24
2,554	80,853	2,967	86,850	2,765	98,325	25
	368,058		489,769		675,586	26
3,833	22,835	2,733	16,691	4,334	37,032	27
	25,932		25,934		28,115	28
	149,970		180,486		208,283	29
16,000,000	1,080,000	16,000,000	1,120,000	40,714,000	1,139,882	30
487,149	129,094	486,979	126,614	433,004	108,251	31
5,062	37,159	7,675	63,050	15,900	96,650	32
288,982	755,864	291,638	755,280	486,235	1,287,080	33
60,000	30,000	60,000	30,000	60,000	30,000	34
1,039,345	2,673,202	1,308,885	3,453,460	1,515,702	5,084,076	35
143,201	391,541	193,364	593,801	174,734	543,249	36
15,973,202	4,920,020	17,612,634	6,212,554	19,708,614	6,867,467	37
2,275	45,590	1,200	32,960	4,830	107,509	38
26,042	58,295	31,306	108,339	41,894	139,528	39
19,520	31,232	6,247	9,371	10,230	18,512	40
47,308	501,029	48,479	534,345	51,020	517,328	41
25,000	1,750,000	33,000	2,310,000	40,146	3,211,680	42
580	6,450	605	10,300	681	11,740	43
75,945	664,632	76,337	675,649	75,085	553,904	44
20,590	57,652	25,149	75,437	35,280	125,598	45
						46
12,516	43,100	13,440	32,395	24,202	211,545	47
57,009	396,936	54,356	411,430	54,655	438,150	48
17,113	112,272	14,860	106,500	12,381	79,644	49
1,361,706	65,730	2,360,000	75,200	2,900,732	167,106	50
1,070		890		2,324		51
1,143	13,671	1,263	19,075	1,280	18,480	52
11,108	95,505	15,957	129,185	9,935	82,278	53
82,676	80,774	129,520	103,534	108,570	70,587	54
740	14,452	3,999	27,564	1,505	50,878	55
23,255,911	4,599,106	28,853,464	8,051,833	39,562,136	6,948,030	56
44,000	1,980	250,776	13,542	350,000	20,000	57
						58
	130,675		160,920		185,770	59
158		600	13,200	400	10,000	60
13,466	26,227	21,425	42,670	29,852	180,345	61
100	350	140	700	230	1,030	62
21,923	365,629	22,231	287,112	24,765	330,805	63
	380,782,607		417,790,671		525,524,074	64
	265,209,975		305,482,183		487,831,631	65
	1,000,000		1,000,000		1,000,000	66
	646,992,582		724,272,854		1,014,355,705	67

Mineral products of the United States for

	Product.	1900. Quantity.	1900. Value.
	METALLIC.		
1	Pig iron, value at Philadelphia ..... long tons..	13,789,242	$259,944,000
2	Silver, commercial value ..... troy ounces..	57,647,000	35,741,100
3	Gold, coining value ..... do....	3,829,897	79,171,000
4	Copper, value at New York City ..... pounds..	606,117,166	98,494,039
5	Lead, value at New York City ..... short tons..	270,824	23,561,688
6	Zinc, value at New York City ..... do....	123,886	10,654,196
7	Quicksilver, value at San Francisco ..... flasks..	28,317	1,302,586
8	Aluminum, value at Pittsburg ..... pounds..	7,150,000	1,920,000
9	Antimony, value at San Francisco ..... short tons..	4,226	837,896
10	Nickel, value at Philadelphia ..... pounds..	9,715	3,886
11	Tin ..... do....	.....	.....
12	Platinum, value (crude) at New York City ..... troy ounces..	400	2,500
13	Total value of metallic products	.....	511,632,891
	NONMETALLIC (SPOT VALUES).		
14	Bituminous coal ..... short tons..	212,316,112	220,930,313
15	Pennsylvania anthracite ..... long tons..	51,221,353	85,757,851
16	Natural gas	.....	23,698,674
17	Petroleum ..... barrels..	63,620,529	75,989,313
18	Clay products	.....	96,212,345
19	Cement ..... barrels..	17,231,150	13,283,581
20	Lime	.....	6,797,496
21	Sand-lime brick	.....	.....
22	Slate	.....	4,240,466
23	Stone	.....	36,970,777
24	Corundum and emery ..... short tons..	4,305	102,715
25	Crystalline quartz ..... do....	14,461	40,705
26	Garnet for abrasive purposes ..... do....	3,185	123,475
27	Grindstones	.....	710,026
28	Infusorial earth and tripoli ..... short tons..	3,615	24,207
29	Millstones	.....	32,858
30	Oilstones, etc	.....	174,087
31	Arsenious oxide ..... pounds..	.....	.....
32	Borax ..... short tons..	[b] 1,602 [c] 24,235	170,036 848,215
33	Bromine ..... pounds..	521,444	140,790
34	Fluorspar ..... short tons..	18,450	94,500
35	Gypsum ..... do....	594,462	1,627,203
36	Lithium ..... do....	520	.....
37	Marls ..... do....	60,000	30,000
38	Phosphate rock ..... long tons..	1,491,216	5,359,248
39	Pyrite ..... do....	204,615	749,991
40	Sulphur ..... short tons..	3,525	88,100
41	Salt ..... barrels..	20,869,342	6,944,603
42	Barytes (crude) ..... short tons..	67,680	188,089
43	Cobalt oxide ..... pounds..	6,471	11,648
44	Mineral paints ..... short tons..	57,426	644,089
45	Zinc white ..... do....	48,840	3,667,210
46	Asbestos ..... do....	1,054	16,310
47	Asphalt ..... do....	54,389	415,958
48	Bauxite ..... long tons..	23,184	89,676
49	Chromic iron ore ..... do....	140	1,400
50	Feldspar ..... short tons..	24,821	180,971
51	Fibrous talc ..... do....	63,500	499,500
52	Fuller's earth ..... do....	9,698	67,535
53	Glass sand ..... do....	.....	.....
54	Graphite (crystalline) ..... pounds..	5,507,855	197,579
55	Graphite (amorphous) ..... short tons..	611	
56	Magnesite ..... do....	2,252	19,333
57	Manganese ores ..... long tons..	11,771	100,289
58	Mica (sheet) ..... pounds..	456,283	92,758
59	Mica (scrap) ..... short tons..	5,497	55,202
60	Mineral waters ..... gallons sold..	47,558,784	6,245,172
61	Monazite and zircon ..... pounds..	908,000	48,805
62	Precious stones	.....	233,170
63	Pumice stone ..... short tons..	.....	.....
64	Quartz (flint) ..... do....	32,495	86,351
65	Rutile ..... pounds..	300	1,300
66	Talc and soapstone ..... short tons..	27,943	383,541
67	Tungsten ..... do....	46	11,040
68	Uranium and vanadium ..... do....	.....	.....
69	Total value of nonmetallic mineral products	.....	594,398,501
70	Total value of metallic products	.....	511,632,891
71	Estimated value of mineral products unspecified	.....	1,000,000
72	Grand total	.....	1,107,031,392

[a] No metallic tin; about 20 tons of high-grade concentrates shipped to England from South Carolina.

the calendar years 1880–1908—Continued.

1901.		1902.		1903.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
15,878,354	$242,174,000	17,821,307	$372,775,000	18,009,252	$344,350,000	1
55,214,000	33,128,400	55,500,000	29,415,000	54,300,000	29,322,000	2
3,805,500	78,666,700	3,870,000	80,000,000	3,560,000	73,591,700	3
602,072,519	87,300,515	659,508,644	76,568,954	698,044,517	91,506,006	4
270,700	23,280,200	270,000	22,140,000	282,000	23,520,000	5
140,822	11,265,760	156,927	14,625,596	159,219	16,717,995	6
29,727	1,382,305	34,291	1,467,848	35,620	1,544,934	7
7,150,000	2,238,000	7,300,000	2,284,590	7,500,000	2,284,900	8
2,639	539,902	3,561	634,506	3,128	548,433	9
6,700	3,551	5,748	2,701	114,200	45,900	10
				(*a*)		11
1,408	27,526	94	1,814	110	2,080	12
	480,006,859		599,916,009		583,433,948	13
225,828,149	236,422,049	260,216,844	290,858,483	282,749,348	351,687,933	14
60,242,560	112,504,020	36,940,710	76,173,586	66,613,454	152,036,448	15
	27,066,077		30,867,863		35,807,860	16
69,389,194	66,417,335	88,766,916	71,178,910	100,461,337	94,694,050	17
	110,211,587		122,169,531		131,062,421	18
20,068,737	15,786,789	25,753,504	25,366,380	29,899,140	31,931,341	19
	8,204,054		9,335,618		9,255,882	20
					155,040	21
	4,787,525		5,696,051		6,256,885	22
	47,284,183		54,798,682		57,433,141	23
4,305	146,040	4,251	104,605	2,542	64,102	24
14,050	41,500	15,104	84,335	8,938	76,908	25
4,444	158,100	3,926	132,820	3,950	132,500	26
	580,703		667,431		721,446	27
4,020	52,950	5,665	53,244	9,219	76,273	28
	57,179		59,808		52,552	29
	158,300		221,762		366,857	30
600,000	18,000	2,706,000	81,180	1,222,000	36,691	31
b 5,344	697,307	*b* 17,404	2,447,614	*c* 34,430	661,400	32
c 17,887	314,811	*c* 2,600	91,000			
552,043	154,572	513,893	128,472	598,500	167,580	33
19,586	113,803	48,018	271,832	42,523	213,617	34
633,791	1,506,641	816,478	2,089,341	1,041,704	3,792,943	35
1,750	43,200	1,245	25,750	1,155	23,425	36
99,880	124,880	12,439	12,741	34,211	22,521	37
1,483,723	5,316,403	1,490,314	4,693,444	1,581,576	5,319,294	38
241,691	1,257,879	207,874	947,089	*d* 233,127	1,109,818	39
(*d*)	(*d*)	(*d*)	(*d*)			40
20,566,661	6,617,449	23,849,231	5,668,636	18,968,089	5,286,988	41
49,070	157,844	61,668	203,154	50,397	152,150	42
13,360	24,048	3,730	6,714	120,000	228,000	43
52,209	636,145	60,191	745,227	56,262	500,922	44
46,500	3,720,000	52,645	4,016,499	62,962	4,801,718	45
747	13,498	1,005	16,200	887	16,760	46
63,134	555,335	105,458	765,048	101,255	1,005,446	47
18,905	79,914	27,322	120,366	48,087	171,306	48
368	5,790	315	4,567	150	2,250	49
34,741	220,422	45,287	250,424	41,891	256,733	50
69,200	483,600	71,100	615,350	60,230	421,600	51
14,112	96,835	11,492	98,144	20,693	190,277	52
		943,135	807,797	823,044	855,828	53
3,967,612	167,714	3,936,824	182,108	4,538,155	225,554	54
809		4,739		16,591		55
3,500	10,500	2,830	8,490	3,744	10,595	56
11,995	116,722	7,477	60,911	2,825	25,335	57
360,060	98,859	373,266	83,843	619,600	118,088	58
2,171	19,719	1,400	35,006	1,659	25,040	59
55,771,188	7,586,962	64,859,451	8,793,761	51,242,757	9,041,078	60
748,736	59,262	802,000	64,160	865,000	65,200	61
	289,050		328,450		307,900	62
		700	2,750	885	2,665	63
34,420	149,297	36,365	144,209	55,233	156,947	64
44,250	5,710	(*e*)				65
28,643	424,888	26,854	525,157	26,671	418,460	66
179	27,720	184	34,040	292	43,639	67
375		3,810	48,125	30	5,625	68
	660,993,170		722,186,708		907,495,032	69
	480,006,859		599,916,009		583,433,948	70
	1,000,000		1,000,000		1,000,000	71
	1,142,000,029		1,323,102,717		1,491,928,980	72

b Refined. *c* Crude. *d* Included under pyrite. *e* Included under estimated unspecified products.

Mineral products of the United States for the calendar years 1880–1908—Continued.

Product.	1904.		1905.	
	Quantity.	Value.	Quantity.	Value.
METALLIC.				
Pig iron (spot value)..long tons..	16,497,033	$233,025,000	22,992,380	$382,450,000
Silver, commercial value..troy ounces..	57,682,800	33,456,000	56,101,600	34,221,976
Gold, coining value..do..	3,892,480	80,464,700	4,265,742	88,180,700
Copper, value at New York City..pounds..	812,537,267	105,629,845	901,907,843	139,795,716
Lead, value at New York City..short tons..	307,000	26,402,000	302,000	28,690,000
Zinc, value at New York City..do..	186,702	18,670,200	203,849	24,054,182
Quicksilver, value at San Francisco..flasks..	34,570	1,503,795	30,451	1,103,120
Aluminum, value at Pittsburg..pounds..	8,600,000	2,477,000	11,347,000	3,246,300
Antimony, value, San Francisco..short tons..	3,057	505,524	3,240	705,787
Nickel, value at Philadelphia..pounds..	24,000	11,400	.....	.....
Tin..do..	.....	.....	None.	.....
Platinum, value at New York City, troy ounces	200	4,160	318	5,320
Total value of metallic products	.....	502,149,624	.....	702,453,101
NONMETALLIC (SPOT VALUES).				
Bituminous coal..short tons..	278,659,689	305,397,001	315,062,785	334,658,294
Pennsylvania anthracite..long tons..	65,318,490	138,974,020	69,339,152	141,879,000
Natural gas	.....	38,496,760	.....	41,562,855
Petroleum..barrels..	117,080,960	101,175,455	134,717,580	84,157,399
Clay products	.....	131,023,248	.....	149,697,188
Cement..barrels..	31,675,257	26,031,920	40,102,308	35,931,533
Lime..short tons..	2,707,809	9,951,456	2,984,100	10,941,680
Sand-lime brick	.....	463,128	.....	972,064
Slate	.....	5,617,195	.....	5,496,207
Stone	.....	58,765,715	.....	63,798,748
Corundum and emery..short tons..	1,916	56,985	2,126	61,464
Crystalline quartz..do..	31,940	74,850	19,039	88,118
Garnet for abrasive purposes..do..	3,854	117,581	5,050	148,095
Grindstones	.....	881,527	.....	777,606
Infusorial earth and tripoli..short tons..	6,274	44,164	10,977	64,637
Millstones	.....	37,338	.....	37,974
Oilstones, etc	.....	188,985	.....	244,546
Arsenious oxide..pounds..	72,413	2,185	1,507,386	35,210
Borax (crude)..short tons..	45,647	698,810	46,334	1,019,154
Bromine..pounds..	897,100	269,130	1,192,758	178,914
Fluorspar..short tons..	36,452	234,755	57,385	362,488
Gypsum..do..	940,917	2,784,325	1,043,202	3,029,227
Lithium minerals..do..	577	5,155	79	1,412
Marls..do..	18,989	13,145	38,026	16,494
Phosphate rock..long tons..	1,874,428	6,580,875	1,947,190	6,763,403
Pyrite..do..	334,373	3,478,568	253,000	938,492
Sulphur..do..			181,677	3,706,560
Salt..barrels..	22,030,002	6,021,222	25,966,122	6,095,922
Barytes (crude)..short tons..	65,727	174,958	48,235	148,803
Cobalt oxide..pounds..	22,000	42,600	.....	.....
Mineral paints..short tons..	64,592	1,448,551	70,355	1,932,048
Zinc white..do..	63,363	4,808,482	68,603	5,520,240
Asbestos..do..	1,480	25,740	3,109	42,975
Asphalt..do..	108,572	879,836	115,267	758,153
Bauxite..long tons..	47,661	235,704	48,129	240,292
Chromic iron ore..do..	123	1,845	22	375
Feldspar..short tons..	45,188	266,326	35,419	226,157
Fibrous talc..do..	64,005	507,400	56,500	445,000
Fuller's earth..do..	29,480	168,500	25,178	214,497
Glass sand..do..	858,719	796,492	1,060,334	1,107,730
Graphite (crystalline)..pounds..	5,681,177	321,372	6,036,567	318,211
Graphite (amorphous)..short tons..	16,927		21,953	
Magnesite..do..	2,850	9,298	3,933	15,221
Manganese ores..long tons..	3,146	29,466	4,118	36,214
Mica (sheet)..pounds..	668,358	109,462	924,875	160,732
Mica (scrap)..short tons..	1,096	10,854	1,126	17,856
Mineral waters..gallons sold..	50,723,500	7,198,450	47,590,081	6,811,611
Monazite and zircon..pounds..	745,999	85,038	1,352,418	163,908
Precious stones	.....	324,300	.....	326,350
Pumice stone..short tons..	1,530	5,421	1,832	5,540
Quartz (flint)..do..	52,270	100,590	51,145	104,109
Rutile..pounds..	.....	7,000	.....	.....
Sand, molding, etc., and gravel..short tons..	9,821,009	4,951,607	22,144,633	10,115,915
Talc and soapstone..do..	27,184	433,331	40,134	637,062
Tungsten..do..	740	184,000	803	268,676
Uranium and vanadium..do..	45	10,600	4	375
Total value of nonmetallic mineral products	.....	860,522,721	.....	2,282,734
Total value of metallic products	.....	502,149,624	.....	702,453,101
Estimated value of mineral products unspecified	.....	400,000	.....	400,000
Grand total	.....	1,363,072,345	.....	1,625,135,835

Mineral products of the United States for the calendar years 1880–1908—Continued.

Product.	1906.		1907.	
	Quantity.	Value.	Quantity.	Value.
METALLIC.				
Pig iron, spot value.....long tons..	25,307,191	$505,700,000	25,781,361	$529,958,000
Silver, commercial value.....troy ounces..	56,517,900	38,256,400	56,514,700	37,299,700
Gold, coining value.....do....	4,565,333	94,373,800	4,374,827	90,435,700
Copper, value at New York City..pounds..	917,805,682	177,595,888	868,996,491	173,799,300
Lead, value at New York City..short tons..	350,153	39,917,442	365,166	38,707,596
Zinc, value at New York City.....do....	199,694	24,362,668	223,745	26,401,910
Quicksilver, value at San Francisco.flasks..	26,238	958,634	21,567	828,931
Aluminum, value at Pittsburg....pounds..	14,910,000	4,262,286	17,211,039	4,926,948
Antimony, value, San Francisco, short tons.	1,766	602,949	351	77,300
Antimonial lead.....do....	.....	.....	9,910	1,322,985
Nickel, value at Philadelphia.....pounds..	.....	(a)	.....	(a)
Tin.....do....	.....	35,600	.....	33,285
Platinum, value at New York City, troy ounces.....	1,439	45,189	357	10,589
Total value of metallic products.....	.....	886,110,856	.....	903,802,244
NONMETALLIC (SPOT VALUES).				
Bituminous coal.....short tons..	342,874,867	381,162,115	394,759,112	451,214,842
Pennsylvania anthracite.....long tons..	63,645,010	131,917,694	76,432,421	163,584,056
Natural gas.....	.....	46,873,932	.....	54,222,399
Petroleum.....barrels..	126,493,936	92,444,735	166,095,335	120,106,749
Clay products.....	.....	161,032,722	.....	158,942,369
Cement.....barrels..	51,000,445	55,302,277	52,230,342	55,903,851
Lime.....short tons..	3,198,087	12,480,653	3,092,524	12,656,705
Sand-lime brick.....	.....	1,170,005	.....	1,225,769
Slate.....	.....	5,668,346	.....	6,019,220
Stone.....	.....	66,378,794	.....	71,105,805
Corundum and emery.....short tons..	1,160	44,310	1,069	12,294
Abrasive quartz and feldspar.....do....	24,082	121,671	17,435	126,582
Garnet for abrasive purposes.....do....	4,650	157,000	7,058	211,686
Irindstones.....	.....	744,894	.....	896,022
Infusorial earth and tripoli.....short tons..	8,099	72,108	.....	104,406
Millstones.....	.....	48,590	.....	31,741
Oilstones, etc.....	.....	268,070	.....	264,188
Arsenious oxide.....pounds..	1,474,000	63,460	3,502,000	163,000
Borax (crude).....short tons..	58,173	1,182,410	52,850	1,121,520
Bromine.....pounds..	1,283,250	165,204	1,379,496	195,281
Fluorspar.....short tons..	40,796	244,025	49,486	287,282
Gypsum.....do....	1,540,585	3,837,975	1,751,748	4,942,264
Lithium minerals.....do....	383	7,411	530	11,000
Marls.....do....	19,104	7,341	14,091	8,429
Phosphate rock.....long tons..	2,080,957	8,579,437	2,265,343	10,653,558
Pyrite.....do....	261,422	931,305	247,387	794,949
Sulphur.....do....	294,153	5,096,678	293,106	5,142,850
Salt.....barrels..	28,172,380	6,658,350	29,704,128	7,608,323
Barytes (crude).....short tons..	50,231	160,367	89,621	291,777
Cobalt oxide.....pounds..	.....	(a)	.....	(a)
Mineral paints.....short tons..	66,033	2,161,461	71,973	2,979,158
Zinc oxide.....do....	74,680	5,999,375	71,784	6,490,660
Asbestos.....do....	1,695	28,565	653	11,899
Asphalt.....do....	138,059	1,290,340	223,861	2,826,489
Bauxite.....long tons..	75,332	368,311	97,776	480,330
Chromic iron ore.....do....	107	1,800	290	5,640
Feldspar.....short tons..	75,656	401,531	84,544	499,069
Fibrous talc.....do....	61,672	557,200	67,800	626,000
Fuller's earth.....do....	32,040	265,400	32,851	291,773
Glass sand.....do....	1,089,430	1,208,788	1,187,296	1,250,067
Graphite {crystalline.....pounds..	5,887,982	238,064	4,947,840	171,149
Graphite {amorphous.....short tons..	16,853	102,175	26,803	125,821
Magnesite.....do....	7,805	23,415	7,561	22,683
Manganese ores.....long tons..	6,921	88,132	5,604	63,369
Manganiferous ores.....do....	41,300	122,400	103,844	259,473
Mica {sheet.....pounds..	1,423,100	252,248	1,060,182	349,311
Mica {scrap.....short tons..	1,489	22,742	3,025	42,800
Mineral waters.....gallons sold..	48,108,580	8,028,387	52,060,520	7,331,503
Monazite and zircon.....pounds..	847,275	152,560	548,152	65,800
Precious stones.....	.....	b 589,000	.....	b 735,800
Pumice.....short tons..	12,200	16,750	8,112	33,818
Quartz.....do....	66,697	243,012	22,977	157,094
Rutile.....pounds..	.....	.....	.....	(a)
Sand, molding, etc., and gravel..short tons..	31,842,572	11,489,420	40,664,622	13,242,002
Talc and soapstone.....do....	58,972	874,356	72,010	905,047
Tungsten.....do....	928	348,867	1,640	890,048
Uranium and vanadium.....do....	.....	(a)	.....	(a)
Total value of nonmetallic mineral products.....	.....	1,017,696,178	.....	1,167,705,720
Total value of metallic products.....	.....	886,110,856	.....	903,802,244
Estimated value of mineral products unspecified.....	.....	200,000	.....	100,000
Grand total.....	.....	1,904,007,034	.....	2,071,607,964

a Included under unspecified. b Includes pearls valued at $381,000 in 1906 and at $264,500 in 1907.

Mineral products of the United States for the calendar years 1880–1908—Continued.

Product.	1908.	
	Quantity.	Value.
METALLIC.		
Pig iron, spot value.....long tons..	15,936,018	$254,321,000
Silver, commercial value.....troy ounces..	52,440,800	28,050,600
Gold, coining value.....do....	4,574,340	94,560,000
Copper, value at New York City.....pounds..	942,570,721	124,419,335
Lead, value at New York City.....short tons..	310,762	26,104,008
Zinc, value at New York City.....do....	190,749	17,930,406
Quicksilver, value at San Francisco.....flasks..	19,752	824,146
Aluminum, value at Pittsburg.....pounds..	11,152,000	2,434,600
Antimony, value at San Francisco.....short tons..	.....	.....
Antimonial lead.....do....	13,629	1,264,771
Nickel, value at Philadelphia.....pounds..	.....	(a)
Tin.....do....	.....	.....
Platinum, value at New York City.....troy ounces..	750	14,250
Total value of metallic products.....	.....	549,923,116
NONMETALLIC (SPOT VALUES).		
Bituminous coal.....short tons..	332,573,944	374,135,268
Pennsylvania anthracite.....long tons..	74,347,102	158,178,849
Natural gas.....	.....	54,640,374
Petroleum.....barrels..	179,572,479	129,706,258
Peat.....	.....	133,000
Clay products.....	.....	133,197,762
Cement.....barrels..	52,910,925	44,477,653
Lime.....short tons..	2,766,873	11,091,186
Sand-lime brick.....	.....	961,226
Slate.....	.....	6,316,817
Stone.....	.....	65,712,499
Corundum and emery.....short tons..	669	8,745
Abrasive quartz and feldspar.....do....	11,725	79,146
Garnet for abrasive purposes.....do....	1,996	64,620
Grindstones.....	.....	536,095
Infusorial earth and tripoli.....	.....	97,442
Millstones.....	.....	31,420
Oilstones, etc.....	.....	217,284
Pumice.....short tons..	10,569	39,287
Arsenious oxide.....pounds..	.....	(a)
Borax (crude).....short tons..	25,000	975,000
Bromine.....pounds..	1,055,636	102,344
Fluorspar.....short tons..	38,795	225,998
Gypsum.....do....	1,721,829	4,138,560
Lithium minerals.....do....	203	1,550
Marls.....do....	8,469	4,330
Phosphate rock.....long tons..	2,386,138	11,399,124
Pyrite.....do....	222,598	857,113
Sulphur.....do....	369,444	6,668,215
Salt.....barrels..	28,822,062	7,553,632
Barytes (crude).....short tons..	38,527	120,442
Cobalt oxide.....pounds..	.....	(a)
Mineral paints.....short tons..	68,694	2,410,367
Zinc oxide.....do....	56,292	5,072,460
Asbestos.....do....	936	19,624
Asphalt.....do....	185,382	1,888,881
Bauxite.....long tons..	52,167	263,968
Chromic iron ore.....do....	359	7,230
Feldspar.....short tons..	67,240	400,918
Fibrous talc.....do....	70,739	697,390
Fuller's earth.....do....	29,714	278,367
Glass sand.....do....	1,093,553	1,134,599
Graphite {crystalline.....pounds..	2,288,000	132,840
Graphite {amorphous.....short tons..	1,443	75,250
Magnesite.....do....	6,587	19,761
Manganese ores.....long tons..	6,144	62,779
Manganiferous ores.....do....	55,620	132,556
Mica {sheet.....pounds..	972,964	234,021
Mica {scrap.....short tons..	2,417	33,904
Mineral waters.....gallons sold..	56,108,820	7,287,269
Monazite and zircon.....pounds..	422,646	50,718
Precious stones.....	.....	415,063
Quartz.....short tons..	38,825	138,646
Rutile.....	.....	.....
Sand, molding, building, etc., and gravel.....short tons..	36,122,491	12,135,433
Talc and soapstone.....do....	46,615	703,832
Tungsten.....do....	671	229,955
Uranium and vanadium.....do....	.....	.....
Total value of nonmetallic mineral products.....	.....	1,045,497,070
Total value of metallic products.....	.....	549,923,116
Estimated value of mineral products unspecified.....	.....	250,000
Grand total.....	.....	1,595,670,186

(a) Included under unspecified.

OUTPUT AND VALUE, BY STATES AND TERRITORIES, OF THE MINERAL PRODUCTS OF THE UNITED STATES IN THE CALENDAR YEARS 1907 AND 1908.

In the following table are shown the quantity and the value, by States and Territories, of the mineral products of the United States in 1907 and 1908.

The values for gold and silver are the official figures agreed upon by the United States Geological Survey and the Director of the Mint. The figures for the tonnage (not the value) of pig iron in 1907 and 1908 are taken from the annual reports prepared by Mr. James M. Swank, general manager of the American Iron and Steel Association.[a]

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908.

ALABAMA.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Clay products		$1,754,409		$1,559,606
Coal, short tons	14,250,454	18,405,468	11,604,593	14,647,891
Copper, pounds		[b]		[d]
Gold, fine ounces (troy)	1,325	27,400	1,993	41,200
Graphite, short tons	715	54,000	453	33,750
Iron, pig, long tons	1,686,674	30,100,000	1,397,014	17,341,000
Lime, short tons	85,909	368,902	83,411	325,234
Mica				9,810
Mineral waters, gallons sold	130,800	20,720	99,192	31,583
Natural gas		[c]		[d]
Sand and gravel, short tons	311,659	169,872	348,134	181,179
Silver, fine ounces (troy)	600	400	400	200
Stone		828,847		627,011
Other products		[d] 406,740		[d] 212,344
Total		52,136,749		35,010,808

ALASKA.

Coal, short tons		[e]	3,107	$14,810
Copper, pounds	7,034,763	$1,406,953	4,438,836	585,926
Gold, fine ounces (troy)	894,424	18,489,400	960,669	19,858,800
Silver, do	179,300	118,300	204,600	109,400
Stone		38,110		[f] 40,343
Other products		[g] 147,789		[g] 182,459
Total		20,200,552		20,791,738

ARIZONA.

Clay products		$101,462		$104,992
Copper, pounds	256,778,437	51,355,687	289,523,267	38,217,071
Gold, fine ounces (troy)	128,871	2,664,000	120,937	2,500,000
Lead, short tons	2,340	248,040	1,464	122,976
Lime, do	12,825	84,262	10,819	68,635
Precious stones		21,280		25,700
Silver, fine ounces (troy)	2,903,100	1,916,000	2,900,000	1,551,200
Stone		237,110		451,832
Tungsten		10,769		6,000
Zinc, short tons	77	9,086	152	14,288
Other products		[h] 105,994		[h] 440,140
Total		56,753,650		43,502,834

[a] Ann. Statist. Rept. Am. Iron and Steel Association for the years 1907 and 1908.
[b] Included under Miscellaneous.
[c] Included under Texas.
[d] Includes in 1907: Bauxite, mica, Portland and puzzolan cement, pyrite, sand-lime brick; in 1908: Bauxite, Portland and puzzolan cement, copper, natural gas, pyrite.
[e] Included under California.
[f] Includes small value for Nevada.
[g] Includes in 1907: Graphite, gypsum, tin, mineral waters; in 1908: Graphite, gypsum, lead, marble.
[h] Includes in 1907: Asbestos, Portland cement, mineral waters, sand and gravel, sand-lime brick; in 1908: Asbestos, Portland cement, fluorspar, gypsum, quartz, quicksilver, sand and gravel, sand-lime brick.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

ARKANSAS.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Clay products		$536,286		$508,788
Coal.....short tons	2,670,438	4,473,693	2,078,357	3,499,470
Glass sand.....do	43	32	2,065	1,297
Lead.....do	15	1,590		
Lime.....do	33,472	159,566	27,179	122,290
Manganiferous ores.....long tons	4,133	8,266	4,066	9,149
Mineral waters.....gallons sold	431,511	85,236	1,175,053	229,260
Natural gas		(a)		(b)
Oilstones				81,837
Precious stones		2,800		2,100
Sand and gravel.....short tons	165,070	81,645	249,922	87,555
Slate		8,500		2,500
Stone		315,478		257,001
Zinc.....short tons	1,911	225,498	2,002	188,188
Other products		[b] 488,157		[b] 359,472
Total		6,386,747		5,348,907

CALIFORNIA.

Asphalt.....short tons	131,068	$1,213,957	135,241	$1,347,257
Borax.....do	52,850	1,121,520	25,000	975,000
Cement, Portland.....barrels		(c)		(c)
Chromite.....long tons	290	5,640	359	7,230
Clay products		5,740,537		4,523,745
Coal.....short tons	[d] 24,089	91,813	18,755	54,840
Copper.....pounds	33,696,602	6,739,320	39,643,835	5,232,986
Glass sand.....short tons	11,064	8,179	6,805	5,121
Gold.....fine ounces (troy)	815,288	16,853,500	935,074	19,329,700
Gypsum		141,675		(c)
Lead.....short tons	854	90,524	515	43,260
Lime.....do	84,981	691,851	70,913	581,481
Magnesite.....do	7,561	22,683	6,587	19,761
Manganese ores.....long tons	100	600		
Mineral waters.....gallons sold	1,680,169	460,972	1,960,770	499,872
Natural gas		168,397		307,652
Ocher.....short tons	450	3,970	335	2,250
Petroleum.....barrels	39,748,375	14,699,956	44,854,737	23,433,502
Platinum.....fine ounces (troy)	300	8,898	706	13,414
Precious stones		173,715		168,438
Pyrite.....long tons	51,950	174,549	30,545	131,744
Quicksilver.....flasks	17,431	662,544	16,984	684,716
Salt.....barrels	626,693	302,940	899,028	374,828
Sand and gravel.....short tons	1,233,869	170,687	605,800	135,839
Sand-lime brick		63,150		56,494
Silver.....fine ounces (troy)	1,590,000	1,049,400	1,703,700	911,300
Slate		60,000		60,000
Stone		3,134,429		3,291,585
Zinc.....short tons	140	16,520	27	2,538
Other products		[c] 2,817,510		[c] 2,943,083
Total		56,679,436		65,137,636

COLORADO.

Clay products		$2,041,475		$1,970,081
Coal.....short tons	10,790,236	15,079,449	9,634,973	13,586,988
Copper.....pounds	13,998,496	2,799,699	13,943,878	1,840,592
Fluorspar.....short tons	3,300	11,400	745	[d] 4,518
Glass sand.....do	2,000	2,500	1,000	1,250
Gold.....fine ounces (troy)	1,010,921	20,897,600	1,106,385	22,871,000
Iron, pig.....long tons		(e)		(e)
Lead.....short tons	48,876	5,180,856	28,728	2,413,152
Lime.....do	5,679	28,798	5,615	28,179

[a] Included under Miscellaneous.

[b] Includes in 1907: Bauxite, fuller's earth, oilstones, phosphate rock, sand-lime brick; in 1908: Bauxite, fuller's earth, natural gas, phosphate rock, sand-lime brick.

[c] Includes in 1907: Asbestos, Portland cement, infusorial earth, metallic paint, quartz, talc and soapstone, and tungsten; in 1908: Portland cement, fuller's earth, gypsum, infusorial earth, metallic paint, pig iron, tungsten.

[d] Includes Arizona.

[e] Includes in 1907: Portland cement, fuller's earth, gypsum, graphite, mica, pig iron, sand-lime brick, surphur, uranium, and zinc-lead; in 1908: Portland and natural cement, fluorspar, fuller's earth, graphite, gypsum, pig iron, quartz, sand-lime brick, zinc-lead.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

COLORADO—Continued.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Manganiferous ores.....long tons..	99,711	$251,207	51,554	$123,407
Mica.....	.....	.....	.....	13,330
Mineral waters.....gallons sold..	775,100	154,415	761,150	127,720
Natural gas.....	.....	(a)	.....	(b)
Petroleum.....barrels..	331,851	272,813	379,653	346,403
Precious stones.....	.....	10,790	.....	3,350
Sand and gravel.....short tons..	66,456	22,573	22,731	9,326
Silver.....fine ounces (troy)..	11,495,400	7,587,000	10,150,200	5,429,400
Stone.....	.....	869,328	.....	c 740,253
Tungsten.....	.....	573,643	.....	204,465
Vanadium.....	.....	6,000	.....	.....
Zinc.....short tons..	26,077	3,077,086	24,885	2,339,190
Other products.....	.....	b 12,237,596	.....	b 6,576,883
Total.....	.....	71,105,128	.....	58,629,487

CONNECTICUT.

Feldspar.....short tons..	.....	.....	14,200	$66,259
Lime.....do....	81,433	$358,052	62,070	307,895
Mineral waters.....gallons sold..	307,906	41,439	424,826	36,404
Precious stones.....	.....	133	.....	(d)
Sand and gravel.....short tons..	29,815	26,193	13,657	8,420
Stone.....	.....	1,052,582	.....	e 1,125,799
Other products.....	.....	d 1,911,120	.....	d 1,176,886
Total.....	.....	3,389,519	.....	2,721,663

DELAWARE.

Clay products.....	.....	$190,440	.....	$146,527
Sand and gravel.....short tons..	147,282	63,887	78,993	32,426
Stone.....	.....	158,192	.....	195,761
Other products.....	.....	f 18,919	.....	f 7,788
Total.....	.....	431,438	.....	382,502

DISTRICT OF COLUMBIA.

Clay products.....	.....	$322,084	.....	$268,600
Other products.....	.....	15,210	.....	9,200
Total.....	.....	337,294	.....	277,800

FLORIDA.

Clay products.....	.....	$354,575	.....	$233,162
Fuller's earth.....short tons..	22,960	213,620	.....	.....
Lime.....do....	.....	.....	11,822	62,915
Mineral waters.....gallons sold..	43,430	12,378	123,552	20,569
Phosphate rock.....long tons..	1,357,365	6,577,757	1,692,102	8,484,539
Sand and gravel.....short tons..	15,798	6,609	28,176	17,901
Sand-lime brick.....	.....	109,275	.....	117,040
Stone.....	.....	15,000	.....	41,910
Other products.....	.....	76,540	.....	189,726
Total.....	.....	7,365,754	.....	9,167,762

a Included under Miscellaneous.
b Includes in 1907: Portland cement, fuller's earth, gypsum, graphite, mica, pig iron, sand-lime brick sulphur, uranium, and zinc-lead; in 1908: Portland and natural cement, fluorspar, fuller's earth, graphite, gypsum, natural gas, pig iron, quartz, sand-lime brick, zinc-lead.
c Includes small value for Missouri.
d Includes in 1907: Clay products, infusorial earth, pig iron, abrasive quartz and feldspar, metallic paint quartz, precious stones; in 1908: Clay products, infusorial earth, metallic paint, pig iron, precious stones, quartz, abrasive quartz.
e Includes small value for Rhode Island and Maine.
f Includes in 1907: Mineral waters, sand-lime brick; in 1908: Sand-lime brick, etc.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

GEORGIA.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Clay products		$2,490,237		$1,928,611
Coal.....short tons.	[a] 362,401	499,686	264,822	364,279
Copper.....pounds.		(b)		
Glass sand.....short tons.	4,800	4,800	3,950	3,180
Gold.....fine ounces (troy).	3,135	64,800	2,719	56,200
Lead.....short tons.	2	212		
Lime.....do.	18,349	70,826	11,193	46,780
Mineral waters.....gallons sold.	246,800	28,120	346,198	50,930
Ocher.....short tons.	5,600	57,100	6,035	63,851
Sand and gravel.....do.	226,290	81,991	225,897	77,808
Sand-lime brick		89,582		(c)
Silver.....fine ounces (troy).	700	500	200	100
Stone		1,745,638		1,895,608
Talc and soapstone.....short tons.	739	11,473		(c)
Other products		[c] 1,496,038		[c] 713,534
Total		6,641,003		5,200,881

IDAHO.

Coal.....short tons.	[d] 7,588	$31,119	5,429	$21,832
Copper.....pounds.	9,707,299	1,941,460	7,256,086	957,803
Gold.....fine ounces (troy).	60,754	1,255,900	69,829	1,443,500
Lead.....short tons.	112,569	11,932,314	98,464	8,270,976
Lime.....do.	5,964	49,022	7,373	57,020
Salt.....barrels.	1,600	2,040	1,114	1,413
Silver.....fine ounces (troy).	7,888,400	5,206,300	7,558,300	4,042,900
Stone		65,843		69,394
Zinc.....short tons.	3,508	413,944	581	54,614
Other products		[e] 402,670		[e] 326,930
Total		21,300,612		15,256,382

ILLINOIS.

Cement, natural.....barrels.	284,599	$92,750	188,859	$68,772
Portland.....do.	2,036,093	2,632,576	3,211,168	2,707,044
Clay products		13,220,489		11,559,114
Coal.....short tons.	51,317,146	54,687,382	47,659,690	49,978,247
Fluorspar.....do.	25,128	141,971	31,727	172,838
Glass sand.....do.	235,716	152,619	194,722	139,172
Iron, pig.....long tons.	2,457,768	52,229,000	1,691,944	30,135,000
Lead.....short tons.	498	52,788	363	30,492
Lime.....do.	124,784	559,305	92,549	393,951
Mineral waters.....gallons sold.	720,400	91,760	685,763	58,904
Natural gas		143,577		446,077
Petroleum.....barrels.	24,281,973	16,432,947	33,685,106	22,648,881
Sand and gravel.....short tons.	4,315,275	1,215,034	6,463,026	1,363,850
Silver.....fine ounces (troy).	2,900	1,900	2,000	1,100
Stone		3,789,342		3,134,770
Zinc.....short tons.	1,446	170,628	298	28,012
Other products		[f] 154,396		[f] 34,464
Total		145,768,464		122,900,688

INDIANA.

Cement, natural.....barrels.	400,000	$140,000	212,901	$42,580
Portland.....do.	3,782,841	4,757,860	6,478,165	5,386,563
Clay products		6,858,124		6,740,167
Coal.....short tons.	13,985,713	15,114,300	12,314,890	13,084,297
Glass sand.....do.	30,500	23,000	18,000	13,950
Lime.....do.	107,964	335,151	95,988	293,579
Mineral waters.....gallons sold.	514,366	507,746	615,429	590,879

[a] Includes North Carolina.
[b] Under Miscellaneous.
[c] Includes in 1907: Asbestos, barytes, bauxite, natural and Portland cement, fuller's earth, graphite, mica, pig iron, pyrite, precious stones, tungsten; in 1908: Asbestos, barytes, bauxite, Portland and natural cement, fuller's earth, infusorial earth, mica, pig iron, pyrite, sand-lime brick, talc and soapstone.
[d] Includes Nebraska and Nevada.
[e] Includes in 1907: Antimony, clay products, mica, mineral waters, phosphate rock, sand-lime brick; in 1908: Clay products, phosphate rock, sand-lime brick, stone.
[f] Includes in 1907: Puzzolan cement, infusorial earth, metallic paint, pyrite, quartz, sienna, umber, sand-lime brick; in 1908: Infusorial earth, pyrite, sand-lime brick.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

INDIANA—Continued.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Natural gas		$1,572,605		$1,312,507
Oilstones		21,692		19,358
Petroleum.....barrels..	5,128,037	4,536,930	3,283,629	3,203,883
Sand and gravel.....short tons..	5,588,392	784,718	3,255,955	681,858
Sand-lime brick		95,527		54,413
Stone		3,639,551		3,646,603
Other products		[a] 754,013		[a] 2,224,857
Total		39,141,217		37,295,494

IOWA.

Clay products		$3,728,785		$4,069,497
Coal.....short tons..	7,574,322	12,258,012	7,161,310	11,706,402
Gypsum.....do....		730,383		565,645
Lead.....do....	225	23,850	110	9,240
Lime.....do....	19,944	84,011	18,900	79,400
Mineral waters.....gallons sold..	127,200	30,500	493,500	55,350
Sand and gravel.....short tons..	461,784	110,501	773,512	286,444
Sand-lime brick		55,618		42,881
Stone		564,124		533,282
Zinc.....short tons..	220	25,960	516	48,504
Other products		11,350		[b] 691,892
Total		17,623,094		18,088,537

KANSAS.

Cement, Portland.....barrels..	3,353,925	$4,240,358	3,854,603	$2,874,457
Clay products		2,370,058		2,248,805
Coal.....short tons..	7,322,449	11,159,698	6,245,508	9,292,222
Gypsum.....do....		414,266		281,339
Lead.....do....	1,798	190,588	2,293	192,612
Lime.....do....	4,124	18,131	1,558	8,086
Mineral waters.....gallons sold..	362,252	61,454	370,943	74,380
Natural gas		6,198,583		7,691,587
Petroleum.....barrels..	2,409,521	965,134	1,801,781	746,695
Salt.....do....	2,667,459	962,334	2,588,814	882,984
Sand and gravel.....short tons..	556,625	117,313	320,150	64,328
Stone		860,579		471,126
Zinc.....short tons..	13,850	1,634,300	8,628	811,032
Other products		[c] 739,812		[c] 522,560
Total		29,932,608		26,162,213

KENTUCKY.

Asphalt.....short tons..	13,387	$92,465	11,539	$67,040
Barytes.....do....			5,233	21,504
Clay products		2,611,364		2,239,108
Coal.....short tons..	10,753,124	11,405,038	10,246,553	10,317,162
Fluorspar.....do....	21,058	133,911	6,323	48,642
Glass sand.....do....	7,400	4,592	5,990	4,283
Lead.....do....	75	7,950		
Lime.....do....	4,670	14,945	6,206	21,322
Mineral waters.....gallons sold..	736,920	72,373	797,186	66,112
Natural gas		380,176		424,271
Petroleum.....barrels..	[d] 820,844	862,396	727,767	706,811
Sand and gravel.....short tons..	429,392	259,358	632,308	331,497
Stone		1,002,450		893,447
Zinc.....short tons..	358	42,244	341	32,054
Other products		[e] 2,405,079		[e] 968,703
Total		19,294,341		16,141,956

[a] Includes in 1907: Pig iron, pyrite; in 1908: Pig iron, precious stones, pyrite.
[b] Includes in 1908: Ocher, Portland cement, slate, etc.
[c] Includes in 1907: Natural cement, sand-lime brick, zinc-lead, zinc oxide; in 1908: Natural cement, pottery, pumice, sand-lime brick, zinc-lead, zinc oxide.
[d] Includes Tennessee.
[e] Includes in 1907: Barytes, natural, Portland, and puzzolan cement, infusorial earth, pig iron ocher, sand-lime brick; in 1908: Portland and natural cement, ocher, pig iron, sand-lime brick.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

LOUISIANA.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Clay products		$928,570		$629,924
Glass sand, short tons			2,695	1,911
Mineral waters, gallons sold			400,500	52,020
Natural gas		(a)		(b)
Petroleum, barrels	5,000,221	4,063,033	6,835,130	4,131,173
Salt, do	1,157,621	226,892	947,129	249,733
Sand and gravel, short tons	1,233,750	442,924	814,745	251,402
Other products		b 5,215,300		b 6,796,846
Total		10,876,719		12,113,009

MAINE.

Clay products		$658,913		$542,730
Feldspar, short tons			13,919	123,409
Gold				198
Lime, short tons	159,494	764,140	141,934	661,453
Mineral waters, gallons sold	1,161,832	414,300	1,182,322	394,346
Precious stones		1,100		(c)
Silver				167
Slate		236,606		213,707
Stone		2,147,770		2,027,508
Zinc, short ton	1	118		
Other products		c 172,319		c 81,160
Total		4,395,266		4,044,678

MARYLAND.

Clay products		$1,886,362		$1,441,099
Coal, short tons	5,532,628	6,623,697	4,377,093	5,116,753
Copper, pounds		(d)		(e)
Feldspar, short tons			9,734	51,850
Glass sand, do	13,370	13,215	14,000	13,700
Lime, do	103,423	324,316	103,224	292,623
Mineral waters, gallons sold	1,023,562	110,039	806,673	75,858
Sand and gravel, short tons	574,389	254,833	788,234	390,466
Slate		116,060		102,186
Stone		1,439,355		968,437
Talc and soapstone, short tons	5,067	32,250		(e)
Other products		e 8,555,121		e 3,036,090
Total		19,356,250		11,489,062

MASSACHUSETTS.

Clay products		$2,128,820		$1,647,362
Coal, short tons			50	150
Copper, pounds			7,863	1,038
Glass sand, short tons	7,500	37,734	5,017	25,330
Lime, do	119,072	596,778	107,813	566,022
Mineral waters, gallons sold	4,661,115	208,579	4,395,049	227,907
Precious stones		100		
Sand and gravel, short tons	193,259	103,543	154,031	89,849
Stone		3,218,979		2,955,195
Other products		f 289,648		f 413,096
Total		6,584,181		5,925,949

a Included under Texas.
b Includes in 1907: Mineral waters, sulphur; in 1908: Natural gas, sulphur.
c Includes in 1907: Feldspar, mica, sand and gravel; in 1908: Mica, pottery, precious stones, sand and gravel.
d Under Miscellaneous.
e Includes in 1907: Natural cement, infusorial earth, feldspar, pig iron, sand-lime brick, abrasive quartz, quartz, metallic paint and mortar colors; in 1908: Portland cement, copper, infusorial earth, metallic paint and mortar colors, pig iron, quartz, abrasive quartz, sand-lime brick, talc and soapstone.
f Includes in 1907: Bromine, abrasive quartz, emery, feldspar, fuller's earth, infusorial earth, pig iron, pyrite, quartz, salt, talc; in 1908: Portland cement, emery, fuller's earth, infusorial earth, pig iron, pyrite, abrasive quartz, talc and soapstone.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

MICHIGAN.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Cement, Portland.....barrels..	3,572,668	$4,384,731	2,892,576	$2,556,215
Clay products.....	.....	1,847,764	.....	1,728,790
Coal.....short tons..	2,035,858	3,660,833	1,835,019	3,322,904
Copper.....pounds..	219,131,503	43,826,301	222,289,584	29,342,225
Glass sand.....short tons..	4,300	8,600	17,000	34,000
Gold.....	.....	.....	.....	.....
Gypsum.....	.....	681,351	.....	491,928
Lime.....short tons..	65,822	276,534	68,050	282,023
Mineral waters.....gallons sold..	1,472,679	127,133	2,004,433	88,910
Salt.....barrels..	10,786,630	2,231,129	10,194,279	2,458,303
Sand and gravel.....short tons..	1,020,341	280,995	825,591	336,365
Sand-lime brick.....	.....	172,840	.....	138,809
Silver.....fine ounces (troy)..	331,300	218,700	294,100	157,300
Stone.....	.....	813,336	.....	708,120
Other products.....	.....	[a] 11,712,445	.....	[a] 4,084,906
Total.....	.....	70,242,692	.....	45,730,798

MINNESOTA.

Clay products.....	.....	$1,689,933	.....	$1,508,710
Gold.....	.....	.....	.....	1,265
Lime.....short tons..	20,450	88,900	19,800	85,700
Mineral waters.....gallons sold..	9,654,030	524,800	10,985,536	551,986
Sand and gravel.....short tons..	417,692	130,350	450,306	156,659
Sand-lime brick.....	.....	.....	.....	71,041
Silver.....	.....	.....	.....	5
Stone.....	.....	1,582,126	.....	1,493,706
Other products.....	.....	[b] 1,441,313	.....	[b] 654,950
Total.....	.....	5,457,422	.....	4,524,022

MISSISSIPPI.

Clay products.....	.....	$846,529	.....	$828,739
Mineral waters.....gallons sold..	425,500	93,350	257,200	52,780
Sand and gravel.....short tons..	169,415	75,863	162,577	82,119
Other products.....	.....	8,560	.....	10,880
Total.....	.....	1,024,302	.....	974,518

MISSOURI.

Barytes.....short tons..	44,039	$162,459	16,319	$56,768
Cement, Portland.....barrels..	.....	.....	2,929,504	2,571,236
Clay products.....	.....	6,898,871	.....	5,631,456
Coal.....short tons..	3,997,936	6,540,709	3,317,315	5,444,907
Copper.....pounds..	.....	[c]	.....	[d]
Glass sand.....short tons..	138,483	92,898	111,517	83,106
Lead.....do....	122,856	13,022,736	122,451	10,285,884
Lime.....do....	190,300	877,970	167,060	701,321
Mineral waters.....gallons sold..	667,232	103,314	682,821	86,043
Natural gas.....	.....	17,010	.....	22,592
Sand and gravel.....short tons..	2,936,797	698,076	2,476,641	643,878
Silver.....fine ounces (troy)..	25,300	16,700	49,400	26,400
Stone.....	.....	2,325,611	.....	2,306,058
Sublimed blue } lead.....short tons..	9,911	1,162,232	1,311	121,923
Sublimed white }			9,100	973,700
Zinc.....do....	141,824	16,735,232	123,655	11,623,570
Other products.....	.....	[d] 4,475,613	.....	[d] 920,993
Total.....	.....	53,129,431	.....	41,499,835

[a] Includes in 1907: Bromine, graphite, grindstones, oilstones, pertroleum, pig iron; in 1908: Graphite, grindstones, oilstones, petroleum, pig iron, precious stones.

[b] Includes in 1907: Natural cement, abrasive feldspar, feldspar, pig iron, sand-lime brick; in 1908: Feldspar, Portland cement, pig iron, pottery.

[c] Under Miscellaneous.

[d] Includes in 1907: Portland cement, grindstones, cobalt oxide, petroleum, pig iron, tripoli, zinc-lead; in 1908: Copper, infusorial earth, petroleum, pig iron.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

MONTANA.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Clay products		$272,872		$387,525
Coal, short tons	2,016,857	3,907,082	1,920,190	3,771,248
Copper, pounds	224,263,789	44,852,758	252,503,651	33,330,481
Gold, fine ounces (troy)	167,987	3,472,600	152,865	3,160,000
Lead, short tons	2,035	215,710	2,320	194,880
Lime, do	4,217	25,340	5,121	32,981
Precious stones		229,800		58,397
Silver, fine ounces (troy)	11,129,600	7,345,500	10,356,200	5,539,500
Stone		265,956		[a] 225,709
Tungsten		32,700		
Zinc, short tons			900	84,600
Other products		[b] 43,193		[b] 18,520
Total		60,663,511		46,803,841

NEBRASKA.

Clay products		$953,432		$946,516
Coal		(c)		
Mineral waters, gallons sold			48,498	11,047
Sand and gravel, short tons	374,590	54,227	526,966	80,428
Stone		324,239		338,070
Other products		[d] 52,018		[d] 49,327
Total		1,383,916		1,425,388

NEVADA.

Coal		(e)		
Copper, pounds	1,998,164	$399,633	12,241,372	$1,615,861
Gold, fine ounces (troy)	745,507	15,411,000	565,475	11,689,400
Lead, short tons	3,380	358,280	3,796	318,864
Precious stones		5,525		61,000
Salt, barrels	6,457	3,654	9,714	4,785
Silver, fine ounces (troy)	8,280,500	5,465,100	9,508,500	5,086,100
Zinc, short tons	1,692	199,656	398	37,412
Other products		[f] 245,852		[f] 230,398
Total		22,088,700		19,043,820

NEW HAMPSHIRE.

Clay products		$510,599		$371,640
Copper, pounds			135,139	17,838
Gold, fine ounces (troy)			179	3,700
Mica		7,227		(g)
Mineral waters, gallons sold	343,500	164,943	835,349	259,520
Silver, fine ounces (troy)			6,300	3,400
Stone		647,721		867,028
Other products		[g] 59,870		[g] 91,151
Total		1,390,360		1,614,277

[a] Includes small value for Idaho and Michigan.
[b] Includes in 1907: Arsenic, grindstones, mineral waters, sand and gravel; in 1908: Arsenic, grindstones, pottery, quartz, sand and gravel, sand-lime brick.
[c] Included under Idaho.
[d] Includes in 1907: Mineral waters, pumice, sand-lime brick; in 1908: Pumice, sand-lime brick, tungsten.
[e] Included under Idaho.
[f] Includes in 1907: Antimony, clay products, graphite, gypsum, infusorial earth, lime, sulphur; in 1908: Clay products, graphite, gypsum, lime, sulphur.
[g] Includes in 1907: Precious stones, whetstones; in 1908: Mica, pottery, precious stones, whetstones.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

NEW JERSEY.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Cement, Portland.....barrels..	4,449,896	$4,738,516	3,208,446	$2,416,009
Clay products		16,005,460		12,313,696
Glass sand.....short tons..	87,140	73,914	56,775	46,379
Iron, pig.....long tons..	373,189	7,554,000	225,372	3,370,000
Lime.....short tons..	34,043	167,149	32,700	134,722
Marls.....do....	14,091	8,429		(a)
Mineral waters.....gallons sold..	982,445	103,082	1,199,023	126,603
Sand and gravel.....short tons..	2,124,696	971,345	2,083,686	665,799
Sand-lime brick		22,792		20,819
Slate		8,000		(a)
Stone		1,523,312		1,531,740
Zinc.....short tons..	13,573	1,601,614	6,926	651,044
Other products		a 22,686		a 38,820
Total		32,800,299		21,315,631

NEW MEXICO.

Clay products		$180,284		$140,671
Coal.....short tons..	2,628,959	3,832,128	2,467,937	3,368,753
Copper.....pounds..	10,140,140	2,028,028	4,991,351	658,858
Gold.....fine ounces (troy)..	15,964	330,000	14,817	306,300
Lead.....short tons..	1,927	204,262	586	49,224
Lime.....do....	485	3,866		(b)
Mineral waters.....gallons sold..	65,800	9,120	152,200	16,060
Precious stones		1,570		72,100
Sand and gravel.....short tons..	209,478	50,724	8,250	12,050
Silver.....fine ounces (troy)..	599,500	395,700	400,900	214,500
Stone		381,011		15,955
Tungsten		4,320		(b)
Zinc.....short tons..	136	16,048	134	12,596
Other products		b 80,782		b 70,823
Total		7,517,843		4,937,890

NEW YORK.

Cement, natural.....barrels..	947,929	$633,170	623,618	$441,136
Portland.....do....	2,290,955	2,433,918	1,988,874	1,813,623
Clay products		11,772,874		8,929,224
Feldspar.....short tons..			14,613	53,148
Garnet, abrasive.....do....			1,996	64,620
Glass sand.....do....			5,000	3,500
Graphite.....pounds..			1,932,000	116,100
Gypsum		800,225		760,759
Iron, pig.....long tons..	1,659,752	33,097,000	1,019,495	15,879,000
Lime.....short tons..	137,111	652,205	106,025	529,501
Metallic paint and mortar colors.....do....	6,394	70,771	7,048	65,482
Millstones		23,072		18,341
Mineral waters.....gallons sold..	7,176,815	686,574	8,007,092	877,648
Natural gas		766,157		959,280
Petroleum.....barrels..	1,212,300	2,127,748	1,160,128	2,071,533
Salt.....do....	9,642,178	2,335,150	9,076,743	2,136,738
Sand and gravel.....short tons..	5,254,896	1,767,521	3,701,388	1,349,163
Sand-lime brick		75,462		57,189
Slate		83,485		(c)
Stone		6,993,705		6,157,279
Talc, fibrous.....short tons..	67,800	626,000	70,739	697,390
Other products		c 533,156		c 2,689,207
Total		68,762,815		45,669,861

a Includes in 1907: Graphite, talc and soapstone; in 1908: Marls, slate, ground slate and shale, talc and soapstone.

b Includes in 1907: Gypsum, mica, salt; in 1908: Graphite, gypsum, lime, mica, pottery, salt, tungsten.

c Includes in 1907: Arsenic, aluminum, puzzolan cement, emery, feldspar, graphite, abrasive garnet, infusorial earth, pyrite, quartz, sienna, shale; in 1908: Aluminum, emery, infusorial earth, marl, precious stones, pyrite, quartz, abrasive quartz, slate, slate and shale.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

NORTH CAROLINA.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	5,785	$18,855	.....	(a)
Clay products.....	.....	1,315,822	.....	$943,968
Coal.....	.....	(b)	.....	.....
Copper.....pounds..	544,040	108,808	29,391	3,880
Gold.....fine ounces (troy)..	3,807	78,700	4,716	97,500
Lime.....short tons..	5,000	24,010	5,132	24,750
Mica.....	.....	225,206	.....	127,870
Millstones.....	.....	1,969	.....	4,052
Mineral waters.....gallons sold..	193,479	40,302	160,195	27,163
Monazite and zircon.....pounds..	457,067	54,870	310,196	37,224
Precious stones.....	.....	7,580	.....	(a)
Sand and gravel.....short tons..	4,745	2,191	7,123	2,070
Sand-lime brick.....	.....	38,808	.....	14,000
Silver.....fine ounces (troy)..	25,200	16,600	1,300	700
Stone.....	.....	932,909	.....	800,177
Talc and soapstone.....short tons..	4,085	74,347	3,564	51,443
Other products.....	.....	a 20,404	.....	a 11,150
Total.....	.....	2,961,381	.....	2,145,947

NORTH DAKOTA.

Clay products.....	.....	$287,919	.....	$206,222
Coal.....short tons..	347,760	560,199	320,742	522,116
Natural gas.....	.....	235	.....	2,480
Stone.....	.....	3,260	.....	(c)
Other products.....	.....	d 23,567	.....	d 8,000
Total.....	.....	875,180	.....	738,818

OHIO.

Cement, Portland.....barrels..	1,151,176	$1,377,155	1,521,764	$1,305,210
Clay products.....	.....	30,340,830	.....	26,622,490
Coal.....short tons..	32,142,419	35,324,746	26,270,639	27,897,704
Glass sand.....do....	95,449	104,127	92,487	94,825
Grindstones and pulpstones.....	.....	764,276	.....	482,128
Iron, pig.....long tons..	5,250,687	106,387,000	2,861,325	47,353,000
Lime.....short tons..	322,917	1,239,912	279,080	975,661
Mineral waters.....gallons sold..	1,536,621	121,531	2,409,598	124,938
Natural gas.....	.....	8,718,562	.....	8,244,835
Petroleum.....barrels..	12,207,448	14,769,888	10,858,797	14,178,502
Pyrite.....long tons..	6,816	20,803	6,531	19,929
Salt.....barrels..	3,851,243	979,078	3,427,478	864,710
Sand and gravel.....short tons..	2,883,352	1,411,910	2,404,223	1,043,553
Sand-lime brick.....	.....	11,283	.....	(e)
Stone.....	.....	5,157,970	.....	4,764,309
Other products.....	.....	e 928,268	.....	e 527,541
Total.....	.....	207,657,339	.....	134,499,335

OKLAHOMA.

Asphalt.....short tons..	5,038	$20,770	2,402	$23,820
Clay products.....	.....	664,512	.....	562,929
Coal.....short tons..	3,642,658	7,433,914	2,948,116	5,976,504
Lead.....do....	404	42,824	1,409	118,356
Mineral waters.....gallons sold..	69,725	7,345	534,114	52,779
Natural gas.....	.....	417,221	.....	860,159
Petroleum.....barrels..	43,524,128	17,513,524	45,798,765	17,694,843

a Includes in 1907: Abrasive garnet, quartz, tin; in 1908: Barytes, precious stones.
b Included under Georgia.
c Included under Oregon.
d Includes in 1907: Natural cement, sand-lime brick; in 1908: Sand-lime brick, etc.
e Includes in 1907: Bromine, natural and puzzolan cement, gypsum, metallic paint and mortar colors, oilstones; in 1908: Natural and puzzolan cement, gypsum, metallic paint and mortar colors, oilstones, sand-lime brick.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

OKLAHOMA—Continued.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Salt ..... barrels..	800	$910	.....	(a)
Sand and gravel ..... short tons..	108,560	22,506	119,940	$35,971
Stone	.....	274,326	.....	337,429
Zinc ..... short tons..	719	84,842	2,235	210,090
Other products	.....	a 426,274	.....	a 713,871
Total	.....	26,908,968	.....	26,586,751

OREGON.

Clay products	.....	$545,839	.....	$555,768
Coal ..... short tons..	70,981	166,304	86,259	236,021
Copper ..... pounds..	518,694	103,739	271,191	35,797
Gold ..... fine ounces (troy)..	59,124	1,222,200	43,823	905,900
Lead ..... short tons..	.....	.....	7	588
Lime ..... do....	4,095	39,738	3,274	28,795
Mineral waters ..... gallons sold..	24,225	5,556	25,350	8,830
Natural gas	.....	100	.....	250
Platinum ..... fine ounces (troy)..	57	1,691	44	836
Sand and gravel ..... short tons..	504,142	289,422	616,034	524,984
Silver ..... fine ounces (troy)..	96,000	63,400	56,100	30,000
Stone	.....	127,279	.....	b 286,414
Other products	.....	c 73,419	.....	c 129,251
Total	.....	2,638,587	.....	2,743,434

PENNSYLVANIA.

Cement:				
Natural ..... barrels..	625,871	$263,969	252,479	$87,192
Portland ..... do....	20,393,965	19,698,006	18,254,806	13,899,807
Clay products	.....	20,291,621	.....	14,842,982
Coal:				
Anthracite ..... long tons..	76,432,421	163,584,056	74,347,102	158,178,849
Bituminous ..... short tons..	150,143,177	155,664,026	117,179,527	118,816,303
Feldspar ..... do....	.....	.....	14,089	103,502
Glass sand ..... do....	370,977	489,989	405,028	484,353
Graphite ..... pounds..	1,674,000	51,960	356,000	16,740
Iron, pig ..... long tons..	11,348,549	234,952,000	6,987,191	111,385,000
Lime ..... short tons..	655,166	2,075,842	582,352	1,883,496
Metallic paint and mortar colors ..... do....	10,327	127,973	9,197	113,112
Millstones	.....	2,016	.....	1,073
Mineral waters ..... gallons sold..	1,287,063	235,807	1,430,489	197,497
Natural gas	.....	18,844,156	.....	19,104,944
Ocher ..... short tons..	8,047	76,816	9,286	78,956
Petroleum ..... barrels..	9,999,306	17,579,706	9,424,325	16,881,194
Sand and gravel ..... short tons..	5,428,471	2,292,579	3,725,414	1,718,703
Sand-lime brick	.....	48,410	.....	64,123
Slate	.....	3,855,640	.....	3,902,958
Stone	.....	9,132,372	.....	6,371,152
Other products	.....	d 6,874,095	.....	d 4,951,276
Total	.....	657,783,345	.....	473,083,212

RHODE ISLAND.

Mineral waters ..... gallons sold..	245,307	$17,108	594,208	$39,405
Stone	.....	674,898	.....	556,474
Other products	.....	e 245,378	.....	e 112,815
Total	.....	937,384	.....	708,694

a Includes in 1907: Gypsum, lime; in 1908: Portland cement, gypsum, salt.
b Includes small value for North Dakota.
c Includes in 1907: Cobalt oxide, gypsum, precious stones; in 1908: Gypsum, pottery, quicksilver.
d Includes in 1907: Bromine, aluminum, puzzolan cement, abrasive garnet, abrasive quartz, feldspar, precious stones, quartz, salt, sienna, shale, talc, umber, zinc oxide; in 1908: Aluminum, puzzolan cement, quartz, abrasive quartz, salt, sienna, slate and shale, talc, umber, zinc oxide.
e Includes in 1907: Clay products, lime, talc; in 1908: Clay products, lime, talc.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

SOUTH CAROLINA.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Clay products		$843,379		$615,248
Glass sand, short tons	3,000	2,400	1,970	1,596
Gold, fine ounces (troy)	2,811	58,100	2,598	53,700
Manganese ores, long tons	800	4,800		
Mica		13,935		2,899
Mineral waters, gallons sold	786,754	195,182	271,572	70,937
Monazite, pounds	91,085	10,930	112,450	13,494
Phosphate rock, long tons	257,221	980,867	225,495	989,881
Sand and gravel, short tons	2,824	2,018	4,434	1,814
Silver, fine ounces (troy)	100	100	200	100
Stone		129,377		297,874
Other products		[a] 64,115		[a] 33,458
Total		2,305,203		2,081,001

SOUTH DAKOTA.

Clay products		$40,107		$63,847
Gold, fine ounces (troy)	200,185	4,138,200	374,529	7,742,200
Lead, short tons			13	1,092
Lime, do	3,673	24,895	5,254	34,068
Natural gas		19,500		24,400
Precious stones		5,200		[b]
Silver, fine ounces (troy)	106,600	70,400	197,300	105,500
Stone		155,875		131,994
Other products		[b] 484,652		[b] 425,133
Total		4,938,829		8,528,234

TENNESSEE.

Barytes, short tons	20,861	$37,138	8,618	$12,313
Clay products		1,613,862		1,236,434
Coal, short tons	6,810,243	8,490,334	6,199,171	7,118,499
Copper, pounds	19,475,119	3,895,024	19,710,103	2,601,734
Gold, fine ounces (troy)	184	3,800	179	3,700
Iron, pig, long tons	393,106	7,542,000	290,826	4,011,000
Lead, short tons	16	1,696		
Lime, do	66,699	263,323	73,016	226,463
Manganese ores, long tons	100	1,500		
Mineral waters, gallons sold	758,312	85,249	712,912	68,693
Natural gas		300		350
Petroleum, barrels		[c]		
Phosphate rock, long tons	638,612	3,047,836	455,431	1,877,221
Sand and gravel, short tons	794,364	313,211	797,334	360,074
Silver, fine ounces (troy)	58,300	38,500	60,900	32,600
Stone		1,090,121		[d] 1,310,651
Zinc, short tons	181	21,358	341	32,054
Other products		[e] 79,752		[e] 385,245
Total		26,525,004		19,277,031

TEXAS.

Asphalt, short tons	53,649	$929,857	17,167	$350,440
Clay products		2,557,561		2,066,735
Coal, short tons	1,648,069	2,778,811	1,895,377	3,419,481
Gold, fine ounces (troy)	48	1,000	24	500
Lead, short tons	10	1,060	42	3,528
Lime, do	38,101	186,372	33,725	144,118

[a] Includes in 1907: Fuller's earth, lime, quartz, tin; in 1908: Copper, fuller's earth, lime.
[b] Includes in 1907: Portland cement, gypsum, mica, mineral waters, sand-lime brick, sand and gravel, tin, tantalum; in 1908: Portland cement, copper, gypsum, lithium minerals, mica, precious stones, sand and gravel, sand-lime brick, tungsten.
[c] Included under Kentucky.
[d] Includes small value for Virginia.
[e] Includes in 1907: Bauxite, metallic paint and mortar colors; in 1908: Bauxite, Portland cement, metallic paint and mortar colors, quartz, slate and shale.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

TEXAS—Continued.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Mineral waters.....gallons sold..	1,146,279	$152,233	1,586,634	$151,032
Natural gas.....	.....	[a] 178,276	.....	(b)
Petroleum.....barrels..	12,322,696	10,410,865	11,206,464	6,700,708
Quicksilver.....flasks..	3,686	148,387	2,382	122,260
Salt.....barrels..	356,086	226,540	442,571	255,652
Sand and gravel.....short tons..	283,484	142,294	309,250	140,067
Silver.....fine ounces (troy)..	305,300	201,500	447,000	239,100
Stone.....	.....	497,962	.....	659,574
Zinc.....short tons..	16	1,888	.....	.....
Other products.....	.....	[b] 1,391,854	.....	[b] 959,734
Total.....	.....	19,806,458	.....	15,212,929

UTAH.

Asphalt.....short tons..	20,719	$569,440	19,033	$100,324
Clay products.....	.....	633,387	.....	658,517
Coal.....short tons..	1,947,607	2,959,769	1,846,792	3,119,338
Copper.....pounds..	66,418,370	13,283,674	71,370,370	9,420,889
Gold.....fine ounces (troy)..	247,758	5,121,600	190,922	3,946,700
Lead.....short tons..	61,699	6,540,094	42,455	3,566,220
Lime.....do....	12,671	68,085	12,237	78,346
Precious stones.....	.....	9,500	.....	20,350
Quicksilver.....flasks..	450	18,000	.....	.....
Salt.....barrels..	345,557	199,779	242,678	169,833
Silver.....fine ounces (troy)..	11,406,900	7,528,500	8,451,300	4,520,600
Stone.....	.....	338,382	.....	286,414
Zinc.....short tons..	1,972	232,696	282	26,508
Other products.....	.....	[c] 596,852	.....	[c] 508,082
Total.....	.....	38,099,756	.....	26,422,121

VERMONT.

Clay products.....	.....	$109,500	.....	$89,064
Copper.....pounds..	696,102	139,220	.....	.....
Lime.....short tons..	47,369	254,281	32,691	170,205
Mineral waters.....gallons sold..	88,550	19,948	107,800	16,380
Ocher.....short tons..	.....	(d)	188	2,050
Sand and gravel.....do....	78,734	33,410	80,906	41,636
Silver.....fine ounces (troy)..	3,800	2,500	.....	.....
Slate.....	.....	1,477,259	.....	1,710,491
Stone.....	.....	7,313,739	.....	7,152,624
Talc and soapstone.....short tons..	16,200	82,500	10,755	99,743
Other products.....	.....	[d] 32,500	.....	[d] 30,936
Total.....	.....	9,464,857	.....	9,313,129

VIRGINIA.

Barytes.....short tons..	9,254	$32,833	.....	(e)
Clay products.....	.....	1,611,335	.....	$1,499,130
Coal.....short tons..	4,710,895	4,807,533	4,259,042	3,868,524
Copper.....pounds..	57,008	11,402	25,087	3,312
Glass sand.....short tons..	1,246	4,535	.....	.....
Gold.....fine ounces (troy)..	402	8,300	174	3,600
Iron, pig.....long tons..	478,771	8,963,000	320,458	4,578,000
Lead.....short tons..	82	8,692	13	1,092
Lime.....do....	115,155	447,307	107,209	424,374
Manganese ores.....long tons..	4,604	56,469	6,144	62,779
Mica.....	.....	1,014	.....	7,346

[a] Includes Alabama and Louisiana.

[b] Includes in 1907: Natural and Portland cement, fuller's earth, gypsum, pig iron, precious stones, sand-lime brick; in 1908: Portland and natural cement, copper, fuller's earth, gypsum, natural gas, pig iron, precious stones, sand-lime brick.

[c] Includes in 1907: Antimony, Portland cement, gypsum, mineral waters, petroleum, phosphate rock, sand and gravel, sulphur; in 1908: Bismuth, Portland cement, gypsum, petroleum, phosphate rock, sand and gravel, sulphur.

[d] Includes in 1907: Ocher, oilstones; in 1908: Asbestos, metallic paints, scythestones, umber.

[e] Includes in 1907: Natural and Portland cement, feldspar, gypsum, ocher, rutile, sand-lime brick; in 1908: Barytes Portland cement, feldspar, gypsum, metallic paint, ocher, pottery, salt, sand-lime brick.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

VIRGINIA—Continued.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Millstones		$4,684		$7,954
Mineral waters.....gallons sold..	2,442,075	431,770	2,009,614	207,115
Precious stones		520		
Pyrite.....long tons..	124,740	372,586	116,340	435,522
Sand and gravel.....short tons..	266,976	119,277	449,234	119,095
Silver.....fine ounces (troy)..	200	100	300	200
Slate		173,670		194,356
Stone		760,488		602,072
Talc and soapstone.....short tons..	26,278	631,880	19,616	458,252
Zinc.....do....	771	90,978	910	85,540
Other products		[a] 774,809		[a] 569,132
Total		19,313,182		13,127,395

WASHINGTON.

Clay products		$1,921,934		$2,104,289
Coal.....short tons..	3,680,532	7,679,801	3,024,943	6,690,412
Copper.....pounds.	122,263	24,453	162,201	21,411
Gold.....fine ounces (troy)..	12,689	262,300	12,273	253,700
Lead.....short tons..	281	29,786	391	32,844
Lime.....do....	35,913	238,568	32,343	228,353
Mineral waters.....gallons sold..	68,400	10,820	38,900	13,650
Sand and gravel.....short tons..	403,960	179,800	654,995	261,531
Silver.....fine ounces (troy)..	84,000	55,400	86,800	46,400
Stone		920,254		1,367,191
Tungsten		32,500		
Other products		[b] 262,090		[b] 590,443
Total		11,617,706		11,610,224

WEST VIRGINIA.

Clay products		$3,640,387		$3,261,736
Coal.....short tons..	48,091,583	47,846,630	41,897,843	40,009,054
Glass sand.....do....	171,338	225,003	145,782	174,834
Iron, pig.....long tons..	291,066	6,454,000		(c)
Lime.....short tons..	107,895	290,298	91,747	202,664
Mineral waters.....gallons sold..	135,809	79,659	130,295	79,915
Natural gas		16,670,962		14,837,130
Petroleum.....barrels..	9,095,296	15,852,428	9,523,176	16,911,865
Salt.....do....	156,147	76,527	145,157	70,481
Sand and gravel.....short tons..	333,246	160,435	222,860	101,524
Stone		1,053,867		772,534
Other products		[c] 137,764		[c] 1,044,000
Total		92,487,960		77,465,737

WISCONSIN.

Clay products		$1,127,819		$958,395
Glass sand.....short tons..	2,970	1,930	3,750	2,812
Lead.....do....	3,551	376,406	4,013	337,092
Lime.....do....	219,644	733,996	235,538	831,792
Mineral waters.....gallons sold..	6,839,219	1,526,703	6,084,571	1,413,107
Sand and gravel.....short tons..	964,689	278,464	858,297	309,943
Stone		2,492,141		2,850,920
Zinc.....short tons..	15,273	1,802,214	17,538	1,648,572
Other products		[d] 5,494,652		[d] 2,699,518
Total		13,832,395		11,052,151

[a] Includes in 1907: Natural and Portland cement, feldspar, gypsum, ocher, rutile, sand-lime brick; in 1908: Barytes, Portland cement, feldspar, gypsum, metallic paint, ocher, pottery, salt, sand-lime brick.
[b] Includes in 1907: Antimony, arsenic, Portland cement, precious stones, sand-lime brick; in 1908: Arsenic, Portland cement, pig iron, sand-lime brick.
[c] Includes in 1907: Bromine, Portland cement, grindstones; in 1908: Pig iron, etc.
[d] Includes in 1907: Natural cement, graphite, metallic paint and mortar colors, petroleum, pig iron, abrasive quartz, sand-lime brick; in 1908: Natural cement, graphite, metallic paint and mortar colors, pig iron, pyrite, quartz, abrasive quartz, sand-lime brick, zinc-lead, zinc oxide.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

WYOMING.

Product.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Clay products		$88,340		$52,282
Coal.....short tons	6,252,990	9,732,668	5,489,902	8,868,157
Copper.....pounds	3,026,004	605,201	2,416,197	318,938
Gold.....fine ounces (troy)	455	9,400	368	7,600
Gypsum		125,033		94,935
Lime.....short tons	282	3,220	392	4,246
Natural gas		(*a*)		(*b*)
Precious stones		600		
Silver.....fine ounces (troy)	1,600	1,100	3,500	1,900
Stone		51,262		72,947
Other products		*b* 54,750		*b* 32,336
Total		10,671,574		9,453,341

MISCELLANEOUS PRODUCTS.

Includes in 1907: Antimony, copper, lead, antimonial lead, lime, lithium minerals, natural gas, pearls, pottery, stone; in 1908: Bromine, copper, abrasive feldspar, gold, lead, antimonial lead, lime and stone (Hawaii), mineral waters, peat, silver		$2,521,543		$2,240,835

RECAPITULATION.

	1907.	1908.	Gain (+) or loss (−).	Percentage of gain (+) or loss (−).
Alabama	$52,136,749	$35,010,808	−$17,125,941	−32.85
Alaska	20,200,552	20,791,738	+ 591,186	+ 2.93
Arizona	56,753,650	43,502,834	− 13,250,816	−23.35
Arkansas	6,386,747	5,348,907	− 1,037,840	−16.25
California	56,679,436	65,137,636	+ 8,458,200	+14.92
Colorado	71,105,128	58,629,487	− 12,475,641	−17.55
Connecticut	3,389,519	2,721,663	− 667,856	−19.70
Delaware	431,438	382,502	− 48,936	−11.34
District of Columbia	337,294	277,800	− 59,494	−17.64
Florida	7,365,754	9,167,762	+ 1,802,008	+24.46
Georgia	6,641,003	5,200,881	− 1,440,122	−21.69
Idaho	21,300,612	15,256,382	− 6,044,230	−28.38
Illinois	145,768,464	122,900,688	− 22,867,776	−15.69
Indiana	39,141,217	37,295,494	− 1,845,723	− 4.72
Iowa	17,623,094	18,088,537	+ 465,443	+ 2.64
Kansas	29,932,608	26,162,213	− 3,770,395	−12.60
Kentucky	19,294,341	16,141,956	− 3,152,385	−16.34
Louisiana	10,876,719	12,113,009	+ 1,236,290	+11.37
Maine	4,395,266	4,044,678	− 350,588	− 7.98
Maryland	19,356,250	11,489,062	− 7,867,188	−40.64
Massachusetts	6,584,181	5,925,949	− 658,232	−10.00
Michigan	70,242,692	45,730,798	− 24,511,894	−34.90
Minnesota	5,457,422	4,524,022	− 933,400	−17.10
Mississippi	1,024,302	974,518	− 49,784	− 4.86
Missouri	53,129,431	41,499,835	− 11,629,596	−21.89
Montana	60,663,511	46,803,841	− 13,859,670	−22.85
Nebraska	1,383,916	1,425,388	+ 41,472	+ 3.00
Nevada	22,088,700	19,043,820	− 3,044,880	−13.78
New Hampshire	1,390,360	1,614,277	+ 223,917	+16.10
New Jersey	32,800,299	21,315,631	− 11,484,668	−35.01
New Mexico	7,517,843	4,937,890	− 2,579,953	−34.32
New York	68,762,815	45,669,861	− 23,092,954	−33.58
North Carolina	2,961,381	2,145,947	− 815,434	−27.54

a Included under miscellaneous.

b Includes in 1907: Mineral waters, petroleum, phosphate rock, sand and gravel, sulphur; in 1908: Natural gas, petroleum, phosphate rock, sand and gravel, sulphur.

Output and value, by States and Territories, of the mineral products of the United States in the calendar years 1907 and 1908—Continued.

RECAPITULATION—Continued.

	1907.	1908.	Gain (+) or loss (−).	Percentage of gain (+) or loss (−).
North Dakota	$875,180	$738,818	− $136,362	− 15.58
Ohio	207,657,339	134,499,335	− 73,158,004	− 35.23
Oklahoma	26,908,968	26,586,751	− 322,217	− 1.20
Oregon	2,638,587	2,743,434	+ 104,847	+ 3.97
Pennsylvania	657,783,345	473,083,212	−184,700,133	− 28.08
Rhode Island	937,384	708,694	− 228,690	− 24.40
South Carolina	2,305,203	2,081,001	− 224,202	− 9.73
South Dakota	4,938,829	8,528,234	+ 3,589,405	+ 72.68
Tennessee	26,525,004	19,277,031	− 7,247,973	− 27.33
Texas	19,806,458	15,212,929	− 4,593,529	− 23.19
Utah	38,099,756	26,422,121	− 11,677,635	− 30.65
Vermont	9,464,857	9,313,129	− 151,728	− 1.60
Virginia	19,313,182	13,127,395	− 6,185,787	− 32.02
Washington	11,617,706	11,610,224	− 7,482	− .06
West Virginia	92,487,960	77,465,737	− 15,022,223	− 16.24
Wisconsin	13,832,395	11,052,151	− 2,780,244	− 20.10
Wyoming	10,671,574	9,453,341	− 1,218,233	− 11.42
Total	2,068,986,421	1,593,179,351	−475,807,070	− 23.00
Miscellaneous	2,521,543	2,240,835	− 280,708	− 11.13
Unspecified products	100,000	250,000	+ 150,000	+150.00
Grand total	2,071,607,964	1,595,670,186	−475,937,778	− 22.97

IMPORTS AND EXPORTS.

The following table shows the value for the calendar years 1907 and 1908 of the imports for consumption and of the exports of the mineral products included in this report as furnished by the Bureau of Statistics of the Department of Commerce and Labor. As has been noted elsewhere, "imports for consumption" may or may not be identical with "total imports" for the calendar year. Thus total imports valued at $500,000 may all be entered for consumption, or $50,000 of these imports may be entered in bond and be reported for consumption in the following calendar year. These differences tend to equalize. Thus in the five years from 1903 to 1907, inclusive, the general imports of iron ores exceeded the imports for consumption by less than 7,500 long tons in total imports of over 4,603,000 tons. The difference for a single year may, however, be considerable.

The metallic imports fell off nearly $42,000,000, from $108,600,000 to $66,700,000, or 38.54 per cent, and the metallic exports fell off over $11,300,000, from $111,300,000 to $99,900,000, or 10.22 per cent. The nonmetallic imports decreased from $110,900,000 to $73,200,000, over $37,700,000, or 33.99 per cent, and the nonmetallic exports increased from $162,200,000 to $171,300,000, about $9,100,000, or 5.64 per cent; the total imports decreased $79,500,000, or 36.24 per cent, and the total exports decreased $2,200,000, or 0.81 per cent.

The table shows very plainly the effects of the financial disaster of 1907 on the commerce of the country in 1908, the effects being strongly marked in the case of those industries dependent largely or chiefly on foreign materials. The imports of antimony fell off, in round numbers, 45 per cent, bismuth 20 per cent, chromic iron ore 30 per cent, pig iron (including scrap) 90 per cent (from $5,486,109 to $544,600), the ferro-alloys 71 per cent (from $7,866,000 to

$2,274,000), manganese 25 per cent, platinum 50 per cent, tin 25 per cent, copper 37 per cent, iron ores 43 per cent, lead 51 per cent, and zinc 63 per cent. Nickel showed an increase in imports of about 11 per cent ($254,000). The exports of lead decreased slightly, pig iron (including scrap) 41 per cent, and the exports of copper decreased 11 per cent, the combined decrease in imports and exports of copper amounting to $41,100,000. The exports of iron ores increased 32 per cent, nickel 16 per cent, and zinc 20 per cent.

Among the nonmetallic products, the imports decreased as follows: Arsenic 25 per cent, asbestos 8 per cent, bituminous coal 26 per cent, graphite 57 per cent, mica 71 per cent, potassium salts 20 per cent ($1,415,000), precious stones 57 per cent ($18,000,000), and sodium nitrate 23 per cent ($3,486,000). The imports of paraffin and ozokerite increased over 135 per cent ($186,000 to $438,000), and petroleum over 116 per cent ($286,000 to $617,000). The exports of cement decreased 14 per cent, brick and tile 18 per cent, pottery 13 per cent, bituminous coal 13 per cent, coke 32 per cent, paraffin 32 per cent ($3,200,000), sulphur 23 per cent ($173,000), zinc oxide 21 per cent; the exports of asphalt increased 20 per cent, crude phosphate 10 per cent, and petroleum 18 per cent ($17,400,000).

Value of imports for consumption and of exports of mineral products in the calendar years 1907 and 1908.

METALLIC PRODUCTS.

Product.	Imports.			Exports.		
	1907.	1908.	Increase (+) or decrease (−).	1907.	1908.	Increase (+) or decrease (−).
Aluminum salts	$35,191	$24,929	− $10,262	[a] $304,938	[a] $330,092	+ $25,154
Antimony (metal, regulus, and ore)	1,588,764	878,136	− 710,628			
Antimony salts	98,038	65,898	− 32,140			
Bauxite	93,208	87,823	− 5,385			
Bismuth	325,015	257,397	− 67,618			
Chromic iron ore	491,925	345,960	− 145,965			
Chromium salts	1,710	16,161	+ 14,451			
Cobalt (oxide, ore, and zaffer)	74,849	16,846	− 58,003			
Copper, in ore, matte, ingots, bars, etc	46,912,347	29,664,129	−17,248,218	[b] 103,252,917	[c] 91,809,675	−11,443,242
Iron ores	3,937,483	2,220,132	− 1,717,351	763,422	1,012,924	+ 249,502
Pig iron (including scrap)	5,486,109	544,600	− 4,941,509	1,908,569	1,118,926	− 789,643
Ferrochrome	24,241	6,423	− 17,818			
Ferromanganese	5,354,656	1,860,664	− 3,493,992			
Ferrosilicon	1,049,283	281,590	− 767,693			
Ferrotungsten	39,417	488	− 38,929			
Spiegeleisen	1,399,381	125,054	− 1,274,327			
Lead, in ore, base bullion, pigs, sheets, etc	1,082,944	526,244	− 556,700	[b] 686,096	[c] 599,640	− 86,456
Manganese ores	1,793,143	1,350,223	− 442,920			
Nickel, in ore, matte, oxide, etc	2,243,026	2,497,585	+ 254,559	2,845,663	3,297,988	+ 452,325
Platinum	2,684,642	1,229,873	− 1,454,769			
Quicksilver	6,719	8,216	+ 1,497	192,094	124,960	− 67,134
Tin	[d] 32,151,720	[d] 24,128,322	− 8,023,398			
Uranium salts	8,619	7,145	− 1,474			
Zinc, in ore, pigs, sheets, etc	1,740,059	617,325	− 1,122,734	[b] 1,401,831	[c] 1,683,887	+ 282,056
Total	108,622,489	66,761,163	−41,861,326	111,355,530	99,978,092	−11,377,438
Percentage of increase (+) or decrease (−)			− 38.54			− 10.22

[a] Aluminum and manufactures of.
[b] Including manufactures of copper valued at $5,888,170; of lead, valued at $679,000; of zinc, valued at $186,203.
[c] Including manufactures of copper, $3,162,303; of lead, $599,640; of zinc, $88,485.
[d] Including manufactures and cassiterite valued at $77,457 in 1907; at $102,381 in 1908.

Value of imports for consumption and of exports of mineral products in the calendar years 1907 and 1908—Continued.

NONMETALLIC PRODUCTS.

Product.	Imports.			Exports.		
	1907.	1908.	Increase (+) or decrease (−).	1907.	1908.	Increase (+) or decrease (−).
Alizarin	$782,368	$752,286	− $30,082			
Ammonium sulphate	1,915,908	2,036,270	+ 120,362			
Aniline salts	667,758	450,891	− 216,867			
Arsenic sulphides, etc	574,998	430,400	− 144,598			
Asbestos	1,304,480	1,195,870	− 108,610			
Asphalt	645,464	624,979	− 20,485	[a] $374,476	$451,968	+ $77,492
Barytes	173,425	87,990	− 85,435			
Barium compounds	357,117	319,114	− 38,003			
Borax	100,980	36,764	− 64,216			
Buhrstones and millstones	27,308	18,642	− 8,666			
Cement, hydraulic	2,614,228	1,206,832	− 1,407,396	1,450,841	1,249,229	− 201,612
Clay	337,539	189,454	− 148,085			
Clay products:						
Brick and tile, etc	225,320	147,461	− 77,859	816,971	663,486	− 153,485
Pottery, etc	13,585,612	10,522,791	− 3,062,821	1,131,641	983,760	− 147,881
Coal:						
Anthracite	40,971	73,778	+ 32,807	13,217,985	13,524,595	+ 306,610
Bituminous	5,397,222	3,964,843	− 1,432,379	[b] 26,972,908	[b] 23,361,914	− 3,610,994
Coal-tar products	7,395,035	5,840,125	− 1,554,910			
Coke	596,366	606,294	+ 9,928	3,206,793	2,161,032	− 1,045,761
Corundum and emery	412,630	248,399	− 164,231			
Cryolite	28,902	16,445	− 12,457			
Fertilizers	4,942,084	1,801,073	− 3,141,011	1,641,316	1,141,666	− 499,650
Phosphates, crude	164,343	82,863	− 81,480	8,387,176	9,294,009	+ 906,833
Guano	400,054	92,659	− 307,395			
Flint and flint pebbles	288,371	219,754	− 68,617			
Fuller's earth	122,221	93,413	− 28,808			
Granite	175,303	193,613	+ 18,310			
Graphite	1,777,389	762,367	− 1,015,022			
Grindstones	111,495	80,382	− 31,113			
Gypsum	535,658	354,403	− 181,255			
Hones, oilstones, whetstones	89,939	44,304	− 45,635			
Infusorial earth and rotten stone	27,121	17,252	− 9,869			
Kaolin or china clay	1,582,893	1,129,847	− 453,046			
Lead paints, litharge, orange mineral, red lead, white lead	115,620	88,579	− 27,041	[c]	[c]	
Lime	86,304	28,952	− 57,352	90,379		− 90,379
Magnesite and magnesia	918,946	775,642	− 143,304			
Marble and stone	1,529,769	1,289,413	− 240,356	1,088,991	1,003,251	− 85,740
Mica	925,259	266,058	− 659,201			
Mineral waters	1,165,555	1,033,047	− 132,508			
Natural gas	32,107	22,003	− 10,104			
Ocher	104,585	75,076	− 29,509	[c]	[c]	
Petroleum	286,252	617,659	+ 331,407	91,383,064	108,815,455	+17,432,391
Ozokerite and paraffin	186,182	438,628	+ 252,446	10,209,448	6,922,638	− 3,286,810
Potassium salts	7,038,817	5,623,752	− 1,415,065			
Precious stones, including pearls	31,866,599	13,700,404	−18,166,195			
Pumice	85,647	67,094	− 18,553			
Pyrite	2,581,787	2,624,339	+ 42,552			
Salicylic acid	1,240	1,183	− 57			
Salt	451,282	444,690	− 6,592	232,895	202,338	− 30,557
Sand and gravel	94,871	77,574	− 17,297			
Sienna and umber	62,329	49,129	− 13,200	[c]	[c]	
Slate	5,404	7,227	+ 1,823	220,995	197,216	− 23,779
Sodium nitrate	[d] 14,911,196	[d] 11,424,760	− 3,486,436			
Strontium oxide	1,242	11	− 1,231			
Sulphur	420,175	362,379	− 57,796	734,749	561,534	− 173,215
Talc	126,391	97,096	− 29,295			
Thorium nitrate	152,666	173,239	+ 20,573			
Venetian red	37,869	25,745	− 12,124			
Zinc oxide	357,230	279,674	− 77,556	1,069,924	845,070	− 224,854
Total	110,945,826	73,234,911	−37,710,915	162,230,552	171,379,161	+ 9,148,609
Percentage of increase (+) or decrease (−)			− 33.99			+ 5.64
Grand total	219,568,315	139,996,074	−79,572,241	273,586,082	271,357,253	− 2,228,829
Percentage + or −			− 36.24			− 0.81

[a] Asphalt and manufactures of, fiscal year.

[b] Not including bunker coal laden as fuel in vessels in the foreign trade, which aggregated in value $18,523,594 in 1907 and $19,915,001 in 1908.

[c] Not reported separately by Bureau of Statistics; "all other" paints exported in 1907, $2,540,142; in 1908, $2,395,080.

[d] Including soda ash valued at $66,521 in 1907 and at $38,367 in 1908.

If gold and silver are included, for the sake of rounding out the metallic products mentioned in this report, the metallic imports fell off in 1908 nearly 47 per cent, and the metallic exports increased 2.12 per cent; the total imports decreased about 43 per cent, and the total exports increased 3.58 per cent. The movements of gold and silver, however, are rather financial than commercial; nevertheless the following table is added to show the results mentioned above:

Value of imports for consumption and of exports of mineral products in the calendar years 1907 and 1908, including gold and silver.

Product.	Imports.			Exports.		
	1907.	1908.	Increase (+) or decrease (−).	1907.	1908.	Increase (+) or decrease (−).
Gold (ore, bullion, and coin)	$143,398,072	$50,276,293	−$93,121,779	[a]$55,215,681	[a]$81,215,456	+$25,999,775
Silver (ore, bullion, and coin)	45,912,360	42,224,130	− 3,688,230	[b] 61,625,866	[b] 51,837,671	− 9,788,195
Other metallic	108,622,489	66,761,163	− 41,861,326	111,355,530	99,978,092	− 11,377,438
Total	297,932,921	159,261,586	−138,671,335	228,197,077	233,031,219	+ 4,834,142
Percentage + or −			− 46.54			+ 2.12
Total metallic	297,932,921	159,261,586	−138,671,335	228,197,077	233,031,219	+ 4,834,142
Total nonmetallic	110,945,826	73,234,911	− 37,710,915	162,230,552	171,379,161	+ 9,148,609
Grand total	408,878,747	232,496,497	−176,382,250	390,427,629	404,410,380	+ 13,982,751
Percentage + or −			− 43.14			+ 3.58

[a] Including, in 1907, foreign bullion and coin valued at $1,890,256; in 1908, foreign ore valued at $5,842 and bullion and coin valued at $1,481,998.

[b] Including, in 1907, foreign ore valued at $6,213 and bullion and coin valued at $11,469,281; in 1908, foreign bullion and coin valued at $1,141,900.

IRON ORES, PIG IRON, AND STEEL.

By E. C. Harder.

INTRODUCTION.

The year 1908 marked a great depression in the iron industry of the United States. The greatest decline took place in the fall of 1907, but the depression continued until the middle of 1908, from which time there has been a steady but slow recovery. As a consequence of the depression, the production of iron ore dropped below that of the three preceding years, and the output of pig iron was the lowest since 1901. The total quantity of iron ore produced amounted to 35,983,336 long tons, as compared with 51,720,619 long tons in 1907; the output of pig iron to 15,936,018 long tons, as compared with 25,781,361 tons in 1907, and that of steel to 14,023,247 long tons, as compared with 23,362,594 tons in 1907.

The immediate result of the financial depression of the fall of 1907 was the cessation of operations in a large number of manufacturing plants, blast furnaces, and mines, due to a decrease in the demand for their products. Since the middle of 1908 conditions have been slowly improving, very slowly during the summer, but more rapidly during the fall and winter, so that it is hoped that by the summer of 1909 the normal state of affairs will again prevail. The blast-furnace industry gives probably the best illustration of this rapid decline and subsequent steady improvement. On June 30, 1907, there were 359 furnaces in blast out of a total of 443, which number decreased to 167 by December 31, 1907. There was a gradual increase in activity to March, 1908, when another decline took place, extending to early in June; on June 30, 1908, there were again 168 furnaces in blast. Then furnaces were blown in with increasing rapidity until on December 31, 1908, 236 furnaces out of a total of 459 were in blast. Toward the end of the year the manufacturers were in general running at about two-thirds capacity.

The demand for iron and steel products was reduced over 50 per cent, as compared with previous years, yet the prices did not show such a marked decline as might have been expected, this being due to an agreement among iron makers to desist from destructive competition. Prices of different iron and steel products were fixed at a certain point until it became impracticable to maintain them, when they were promptly lowered without confusion to a new basis. The total decline in prices of finished steel products from January 1 to December 31, according to the Iron Trade Review[a], averaged only about $2.50 per long ton. The decrease in demand was out of all proportion to the decline in prices.

The year 1908 marks an epoch in steel manufacture, for in this year the production of open-hearth steel passed that of Bessemer steel for the first time in the history of steel making in the United States. The tonnage of both, however, was much lower than that of 1907.

[a] Iron Trade Review, December 31, 1908.

The decrease in production of both pig iron and steel in 1908 from that of 1907 was about 40 per cent, while that of iron ore was about 30 per cent.

The accompanying figure shows the production of iron ores, pig iron, and steel since 1870 and illustrates well the great decrease which followed the financial panic of the fall of 1907.

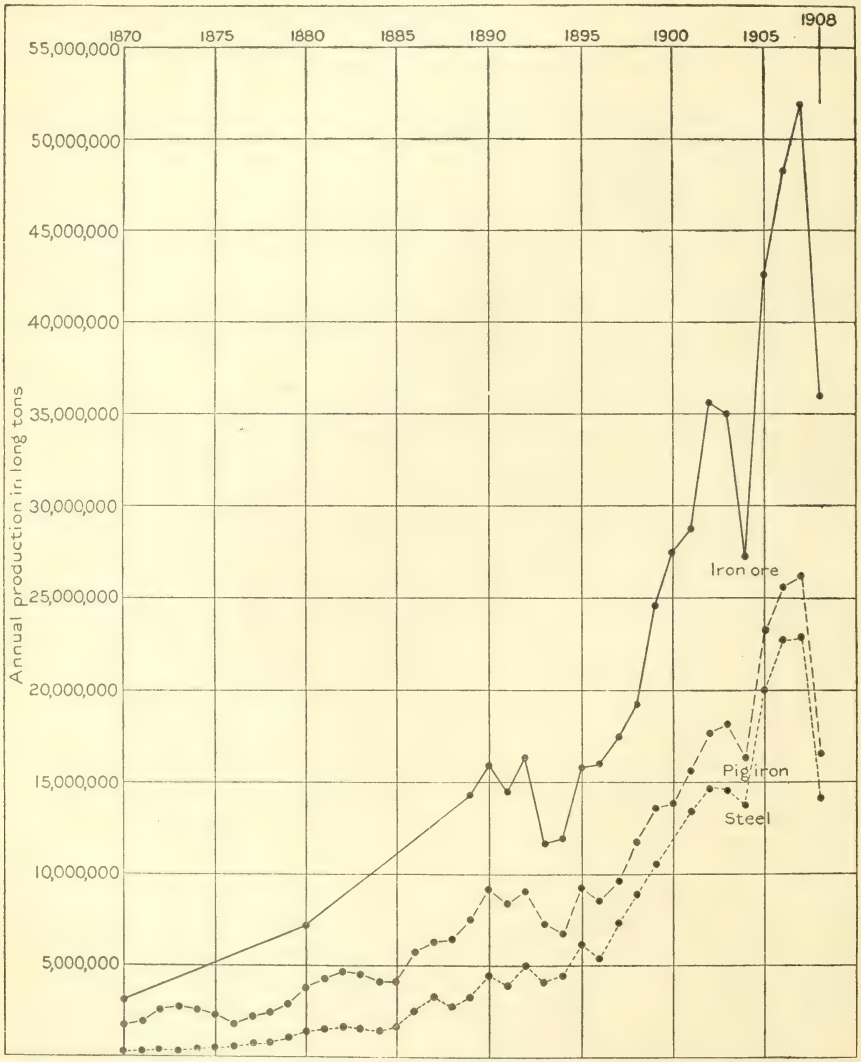

FIGURE 1.—Curve showing the production of iron ore, pig iron, and steel in the United States, 1870–1908, in long tons.

The iron-ore statistics in this and similar previous reports were collected by the United States Geological Survey, the returns being obtained directly from the individual producers. Cordial thanks are due the various mine owners and operators for the promptness with which the reports have been sent in.

The collection of iron-ore statistics was begun in 1889 by John Birkinbine and was continued by him until 1905. Much credit is due

Mr. Birkinbine for the efficient way in which the work has been carried on. The collection of iron and steel statistics was begun in 1854 by the American Iron and Steel Association. Beginning with 1882, extracts of the annual reports of this association by its general manager, James M. Swank, were inserted into the annual volumes of Mineral Resources of the United States as a separate section distinct from iron ores. This policy was continued to 1904. In 1906 the iron-ore work was taken up by E. C. Eckel, and by him iron ore, pig iron, and steel statistics were combined into one chapter, the pig iron and steel statistics being obtained from the American Iron and Steel Association through the courtesy of Mr. Swank. The tables showing the shipments and receipts of Lake Superior ores are quoted from the Iron Trade Review. Mr. Eckel's policy has been continued in the present report by the writer, who hereby expresses his obligation to the various individuals who have been instrumental in gathering these statistics.

The present report, besides the annual statistical tables, contains several historical tables showing the production of iron ores and the foreign trade in them and the production of pig iron and of various kinds of steel in the United States as far as they have been recorded.

It further contains a section on the geologic relations of various kinds of iron ore of the United States, described by districts, and a map showing the different districts and varieties of ore.

There is also incorporated an abstract of a report by C. W. Hayes to the National Conservation Commission, giving estimates of iron-ore reserves of the United States by varieties of ore and by districts.

A separate map, showing the distribution of blast furnaces by districts, has been prepared by W. T. Thom and is submitted herewith.

IRON-ORE INDUSTRY OF THE UNITED STATES.

PRODUCTION OF IRON ORE BY COMMERCIAL DISTRICTS.

The iron ore produced in the United States in 1908 amounted to 35,983,336 long tons, valued at $81,845,904 at the mines, as compared with 51,720,619 long tons, valued at $131,996,147, in 1907—a decrease of 30.43 per cent in tonnage and of 37.99 per cent in value, being the greatest decrease which has taken place during the last twenty years.

Iron ore was mined in 27 States during 1908. Of these, three States produced ores for fluxing purposes only; the rest produced ores for blast-furnace use.

The various States may be conveniently grouped into six commercial districts, namely:

1. *Northeastern district:* Including Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and Ohio.
2. *Southeastern district:* Including Maryland, the Virginias, Kentucky, Tennessee, North Carolina, Georgia, and Alabama.
3. *Lake Superior district:* Including Michigan, Wisconsin, and Minnesota.
4. *Mississippi Valley district:* Including Iowa, Missouri, Arkansas, and Texas.
5. *Rocky Mountain district:* Including Montana, Wyoming, Colorado, New Mexico, Utah, and Nevada.
6. *Pacific Slope district:* Including Washington and California.

Each of these districts may be subdivided into mining districts and the ores classified with regard to variety and to distribution of deposits. These subdivisions are discussed in another section. The Lake Superior is by far the most important of these districts and is followed in order by the southeastern district and the northeastern district; the Mississippi Valley and the western districts are of minor importance. The following table shows the relative output of ore in each of the commercial districts during 1906, 1907, and 1908: [a]

Production of iron ore in the United States by commercial districts in 1906, 1907, and 1908, in long tons.

District.	1906.		1907.		1908.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Northeastern	2,582,666	5.41	2,822,822	5.46	1,590,098	4.42
Southeastern	6,208,140	13.00	6,197,360	11.98	5,484,821	15.24
Lake Superior	38,035,084	79.65	41,638,744	80.51	28,225,412	78.44
Mississippi Valley	117,570	.25	230,435	.44	154,380	.43
Rocky Mountain	806,268	1.69	831,258	1.61	528,625	1.47
Pacific Slope	(b)	.....	(b)	.....	(b)	.....
	47,749,728	100.00	51,720,619	100.00	35,983,336	100.00

[a] Hayes, C. W., Iron ores of the United States: Rept. National Conservation Commission, Sen. Doc. No. 676, 60th Cong., 2d sess., 1908. See also Bull. U. S. Geol. Survey No. 394, 1909, pp. 70–113.
[b] Included in Rocky Mountain district.

PRODUCTION OF IRON ORE BY STATES.

The following table gives a comparison of the iron-ore production by States for 1907 and 1908, showing increase and decrease, and the percentage of increase and decrease in the various States:

Quantity and value of iron ore produced in the United States, 1907 and 1908, by States.

State.	1907.		1908.		Increase (+) or decrease (−) in 1908.		Percentage of increase (+) or decrease (−) in 1908.	
	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.	Quantity, in long tons.	Value.
Alabama	4,039,453	$4,863,129	3,734,438	$4,358,902	− 305,015	− $504,227	− 7.55	−10.37
Arkansas and Texas	118,667	120,060	[a] 55,966	30,663	− 62,701	− 89,397	−52.84	−74.46
Colorado	11,714	21,085	10,176	18,432	− 1,538	− 2,653	−13.13	−12.58
Connecticut and Massachusetts	37,166	136,440	28,112	105,457	− 9,054	− 30,983	−24.36	−22.71
Georgia	444,114	837,102	321,060	540,189	− 123,054	− 296,913	−27.71	−35.47
Kentucky, Maryland, and West Virginia	62,808	95,891	53,235	84,898	− 9,573	− 10,993	−15.24	−11.46
Michigan	11,830,342	36,441,330	8,839,199	25,150,861	− 2,991,143	−11,290,469	−25.28	−30.98
Minnesota	28,969,658	76,668,836	18,652,220	42,313,974	−10,317,438	−34,354,862	−35.61	−44.81
Missouri	[b] 111,768	[b] 226,286	98,414	218,182	− 13,354	− 8,104	−11.95	− 3.58
Montana, Nevada, New Mexico, Utah, and Wyoming	[c] 819,544	[c] 967,190	[c] 518,449	[c] 708,760	− 301,095	− 258,430	−36.74	−26.72
New Jersey	549,760	1,815,586	394,767	1,162,474	− 154,993	− 653,112	−28.19	−35.97
New York	1,375,020	2,820,135	697,473	2,098,247	− 677,547	− 721,888	−49.28	−25.60
North Carolina	50,439	113,488	48,522	76,877	− 1,917	− 36,611	− 3.80	−32.26
Ohio	23,589	41,081	26,585	36,736	+ 2,996	− 4,345	+12.70	−10.58
Pennsylvania	837,287	1,298,717	443,161	572,346	− 394,126	− 726,371	−47.07	−55.93
Tennessee	813,690	1,325,134	635,343	876,007	− 178,347	− 449,127	−21.92	−33.89
Virginia	786,856	1,538,920	692,223	1,465,691	− 94,633	− 73,229	−12.03	− 4.76
Wisconsin	838,744	2,665,737	733,993	2,027,208	− 104,751	− 638,529	−12.49	−23.95
	51,720,619	131,996,147	35,983,336	81,845,904	−15,737,283	−50,150,243	−30.43	−37.99

[a] Texas alone. [b] Includes Iowa. [c] Includes 1907, California and Washington; 1908, Washington.

In the following table the States are arranged according to their rank as producers in 1907 and 1908, with regard both to the quantity and the value of the iron ores produced:

Rank of iron-ore producing States in 1907 and 1908, with quantity and value of product and percentage of each.

1907.

Rank.	State.	Production. Quantity, in long tons.	Production. Percentage of total production.	Rank.	State.	Value. Amount.	Value. Percentage of total.
1	Minnesota	28,969,658	56.11	1	Minnesota	$76,668,836	58.08
2	Michigan	11,830,342	22.87	2	Michigan	36,441,330	27.61
3	Alabama	4,039,453	7.81	3	Alabama	4,863,129	3.69
4	New York	1,375,020	2.66	4	New York	2,820,135	2.14
5	Wisconsin	838,744	1.62	5	Wisconsin	2,665,737	2.02
6	Pennsylvania	837,287	1.62	6	New Jersey	1,815,586	1.38
7	Montana, Nevada, New Mexico, Utah, and Wyoming	[a] 819,544	1.59	7	Virginia	1,538,920	1.17
				8	Tennessee	1,325,134	1.00
				9	Pennsylvania	1,298,717	.98
8	Tennessee	813,690	1.57	10	Montana, Nevada, New Mexico, Utah, and Wyoming	[a] 967,190	.73
9	Virginia	786,856	1.52				
10	New Jersey	549,760	1.06				
11	Georgia	444,114	.86	11	Georgia	837,102	.63
12	Arkansas and Texas	118,667	.23	12	Missouri	[b] 226,286	.17
13	Missouri	[b] 111,768	.22	13	Connecticut and Massachusetts	136,440	.10
14	Kentucky, Maryland, and West Virginia	62,808	.12	14	Arkansas and Texas	120,060	.09
15	North Carolina	50,439	.10	15	North Carolina	113,488	.09
16	Connecticut and Massachusetts	37,166	.07	16	Kentucky, Maryland, and West Virginia	95,891	.07
17	Ohio	23,589	.05	17	Ohio	41,081	.03
18	Colorado	11,714	.02	18	Colorado	21,085	.02
		51,720,619	100.00			131,996,147	100.00

1908.

1	Minnesota	18,652,220	51.84	1	Minnesota	$42,313,974	51.70
2	Michigan	8,839,199	24.56	2	Michigan	25,150,861	30.73
3	Alabama	3,734,438	10.38	3	Alabama	4,358,902	5.33
4	Wisconsin	733,993	2.04	4	New York	2,098,247	2.56
5	New York	697,473	1.94	5	Wisconsin	2,027,208	2.48
6	Virginia	692,223	1.92	6	Virginia	1,465,691	1.79
7	Tennessee	635,343	1.77	7	New Jersey	1,162,474	1.42
8	Montana, Nevada, New Mexico, Utah, and Wyoming	[a] 518,449	1.44	8	Tennessee	876,007	1.07
				9	Montana, Nevada, New Mexico, Utah, and Wyoming	[a] 708,760	.87
9	Pennsylvania	443,161	1.23				
10	New Jersey	394,767	1.10	10	Pennsylvania	572,346	.70
11	Georgia	321,060	.89	11	Georgia	540,189	.66
12	Missouri	98,414	.27	12	Missouri	218,182	.27
13	Arkansas and Texas	[c] 55,966	.16	13	Connecticut and Massachusetts	105,457	.13
14	Kentucky, Maryland, and West Virginia	53,235	.15	14	Kentucky, Maryland, and West Virginia	84,898	.10
15	North Carolina	48,522	.13				
16	Connecticut and Massachusetts	28,112	.08	15	North Carolina	76,877	.09
				16	Ohio	36,736	.04
17	Ohio	26,585	.07	17	Arkansas and Texas	[c] 30,663	.04
18	Colorado	10,176	.03	18	Colorado	18,432	.02
		35,983,336	100.00			81,845,904	100.00

[a] Includes, 1907, California and Washington; 1908, Washington.
[b] Includes Iowa.
[c] Texas alone.

PRODUCTION OF IRON ORE BY VARIETIES, IN VARIOUS STATES AND MINING DISTRICTS.

Iron minerals are classified as sulphides, oxides, carbonates, silicates, etc., of which only the oxides and carbonates are used in the steel industry. The ores of iron are generally classed under four heads:

1. *Hematite:* Including all the anhydrous sesquioxides (Fe_2O_3—theoretical percentage of iron, 70). This is known locally as red hematite, specular ore, gray ore, fossil ore, oolitic ore, etc.
2. *Brown ore:* Including hydrated sesquioxides, such as limonite, göthite, and turgite ($Fe_2O_3nH_2O$—theoretical percentage of iron, 59.8—66). This is known locally as brown iron ore, brown hematite, bog ore, limonite, etc.
3. *Magnetite:* Including magnetic oxides (Fe_3O_4—theoretical percentage of iron, 72.4). Magnetite is known generally as magnetic iron ore.
4. *Iron carbonate:* Including carbonates of various types ($FeCO_3$—theoretical percentage of iron, 48.2). Iron carbonate is known locally as spathic iron ore, kidney ore, black band ore, siderite, etc.

Hematite has always been predominant as an ore of iron, and at present constitutes almost nine-tenths of the iron ores produced. Brown ore and magnetite are far below it in importance, each furnishing at present about one-twentieth of the total iron-ore production. The production of iron carbonate is insignificant in comparison with that of the other ores, constituting only about one-twentieth of 1 per cent of the total.

In the following table are shown the quantities of each of the classes of iron ores produced in the various States during 1907 and 1908:

Production of iron ore in the United States in 1907 and 1908, by States and varieties, in long tons.

1907.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total quantity.
Alabama	3,144,011	895,442	.....	.....	4,039,453
Arkansas and Texas	.....	118,667	.....	.....	118,667
Colorado	.....	11,714	.....	.....	11,714
Connecticut and Massachusetts	.....	37,166	.....	.....	37,166
Georgia	106,885	337,229	.....	.....	444,114
Kentucky, Maryland, and West Virginia	36,000	26,808	.....	.....	62,808
Michigan	11,830,342	.....	.....	.....	11,830,342
Minnesota	28,969,658	.....	.....	.....	28,969,658
Missouri	42,527	[a] 69,241	.....	.....	111,768
Montana, Nevada, New Mexico, Utah, and Wyoming	608,056	[b] 16,000	[c] 195,488	.....	819,544
New Jersey	.....	46,818	502,942	.....	549,760
New York	140,101	10,000	1,224,919	.....	1,375,020
North Carolina	.....	.....	50,439	.....	50,439
Ohio	.....	.....	.....	23,589	23,589
Pennsylvania	19,403	113,076	704,808	.....	837,287
Tennessee	269,182	544,508	.....	.....	813,690
Virginia	89,867	696,518	471	.....	786,856
Wisconsin	804,454	34,290	.....	.....	838,744
	46,060,486	2,957,477	2,679,067	23,589	51,720,619

[a] Includes Iowa. [b] Includes Washington. [c] Includes California.

Production of iron ore in the United States in 1907 and 1908, by States and varieties, in long tons—Continued.

1908.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total quantity.
Alabama	2,775,903	958,535	.....	.....	3,734,438
Arkansas and Texas	.....	[a] 55,966	.....	.....	55,966
Colorado	.....	10,176	.....	.....	10,176
Connecticut and Massachusetts	.....	28,112	.....	.....	28,112
Georgia	1,248	319,812	.....	.....	321,060
Kentucky, Maryland, and West Virginia	7,491	45,744	.....	.....	53,235
Michigan	8,839,199	.....	.....	.....	8,839,199
Minnesota	18,652,220	.....	.....	.....	18,652,220
Missouri	77,400	21,014	.....	.....	98,414
Montana, Nevada, New Mexico, Utah, and Wyoming	354,012	[b] 68,565	95,872	.....	518,449
New Jersey	.....	(c)	[c] 394,767	.....	394,767
New York	33,825	.....	663,648	.....	697,473
North Carolina	.....	.....	48,522	.....	48,522
Ohio	.....	.....	.....	26,585	26,585
Pennsylvania	26,162	73,001	343,998	.....	443,161
Tennessee	226,038	409,305	.....	.....	635,343
Virginia	64,323	626,910	990	.....	692,223
Wisconsin	730,743	3,250	.....	.....	733,993
	31,788,564	2,620,390	1,547,797	26,585	35,983,336

[a] Texas alone. [b] Includes Washington. [c] Brown ore is included in magnetite.

From this table it will be seen that the great bulk of the hematite comes from the Lake Superior district (Michigan, Minnesota, and Wisconsin) and Alabama, the brown ore from the Appalachian States, and the magnetite from New York, New Jersey, and Pennsylvania. All the iron carbonate is obtained from Ohio.

The following table shows the production of the different varieties of iron ores in the principal iron mining districts during 1908:

Production of iron ore in the United States, by mining districts and varieties, in 1908, in long tons.

District.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
Mesabi	17,725,014	.....	.....	.....	17,725,014
Marquette	3,309,917	.....	.....	.....	3,309,917
Gogebic	3,241,931	.....	.....	.....	3,241,931
Menominee[a]	2,904,011	.....	.....	.....	2,904,011
Birmingham	2,597,651	.....	.....	.....	2,597,651
Vermilion	927,206	.....	.....	.....	927,206
Adirondack	(b)	.....	[b] 604,697	.....	604,697
Northern New Jersey and southeastern New York	.....	(c)	[c] 455,118	.....	455,118
Other	1,081,434	2,620,390	489,382	26,585	4,217,791
	31,787,164	2,620,390	1,549,197	26,585	35,983,336

[a] Includes Crystal Falls, Florence, and Iron River districts.
[b] Hematite is included in magnetite.
[c] Brown ore is included in magnetite.

TOTAL PRODUCTION OF IRON ORE.

In the following table is shown the production of the various types of iron ores in the United States as far as has been recorded. The statistics from 1889 to the present were collected by the United States Geological Survey; those for 1860, 1870, and 1880 were collected for the census reports of those years; those for 1875 and 1881 were esti-

mated by I. L. Bell,[a] and those from 1882 to 1888, inclusive, were estimated by James M. Swank [b] from the pig-iron production. No figures can be obtained for the production of various classes of iron ores prior to 1889, except for the census year 1880.

Production of iron ore in the United States, 1860–1908, in long tons.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
1860					2,873,460
1870					3,031,891
1875					4,017,857
1880	2,243,993	1,918,622	2,134,276	823,471	7,120,362
1881					7,119,643
1882					[a] 8,700,000
1883					[a] 8,800,000
1884					[a] 7,718,129
1885					[a] 7,600,000
1886					[a] 10,000,000
1887					[a] 11,300,000
1888					[a] 12,062,530
1889	9,056,288	2,523,087	2,506,415	432,251	14,518,041
1890	10,527,650	2,559,938	2,570,838	377,617	16,036,043
1891	9,327,398	2,757,564	2,317,108	189,108	14,591,178
1892	11,646,619	2,485,101	1,971,965	192,981	16,296,666
1893	8,272,637	1,849,272	1,330,886	134,834	11,587,629
1894	9,347,434	1,472,748	972,219	87,278	11,879,679
1895	12,513,995	2,102,358	1,268,222	73,039	15,957,614
1896	12,576,288	2,126,212	1,211,526	91,423	16,005,449
1897	14,413,318	1,961,954	1,059,479	83,295	17,518,046
1898	16,150,684	1,989,681	1,237,978	55,373	19,433,716
1899	20,004,399	2,869,785	1,727,430	81,559	24,683,173
1900	22,708,274	3,231,089	1,537,551	76,247	27,553,161
1901	24,006,025	3,016,715	1,813,076	51,663	28,887,479
1902	30,532,149	3,305,484	1,688,860	27,642	35,554,135
1903	30,328,654	3,080,399	1,575,422	34,833	35,019,308
1904	23,839,477	2,146,795	1,638,846	19,212	27,644,330
1905	37,567,055	2,546,662	2,390,417	21,999	42,526,133
1906	42,481,375	2,781,063	2,469,294	17,996	47,749,728
1907	46,060,486	2,957,477	2,679,067	23,589	51,720,619
1908	31,788,564	2,620,390	1,547,797	26,585	35,983,336

[a] Figures given are for consumption of domestic ores. Total production for 1882, 1883, and 1884 is estimated as 9,000,000, 8,400,000, and 8,200,000 tons, respectively. See Mineral Resources U. S. for 1883 and 1884.

In the following table the production of iron ores in the United States is shown from 1810 to 1869, and by decades from 1870 to 1908. The figures for the years previous to 1889 were calculated from the pig-iron production and include imported ore as well as domestic ore used.[c]

Production of iron ore in the United States from 1810 to 1908, by decades, estimated from pig-iron production.[d]

1810–1869	long tons	49,656,000
1870–1879	do	43,770,527
1880–1889	do	91,043,854
1890–1899	do	163,989,193
1900–1908	do	332,638,229

PRINCIPAL IRON-ORE MINES.

During 1908, of the 407 iron-ore mines in operation 150 produced over 50,000 long tons of iron ore each, as compared with 169 mines in 1907. The maximum production of any one mine was 2,926,614 tons from the Hull Rust, of the Mesabi range, Minnesota. Four

[a] Bell, I. L., Principles of the Manufacture of Iron and Steel, 1884, p. 451.
[b] Mineral Resources U. S., 1882 to 1888.
[c] Hayes, C. W., Iron ores of the United States: Rept. National Conservation Commission, Sen. Doc. No. 676, 60th Cong., 1909. See also Bull. U. S. Geol. Survey No. 394, 1909, pp. 70–113.
[d] The figures, previous to 1889, include imported ores.

mines, all except one being located in Minnesota, produced 1,000,000 tons each. The exception was the Red Mountain group of the Birmingham district, Alabama.

Permission has been obtained from the owners and operators of 134 of these important mines to publish their production, and this information is given in the following table:

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1908.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity.
1	Hull Rust	Minnesota	Hibbing	Hematite	2,926,614
2	Burt	do	do	do	1,461,068
3	Fayal	do	Eveleth	do	1,450,829
4	Red Mountain Group	Alabama	Bessemer	do	1,329,079
5	Adams	Minnesota	Eveleth	do	781,374
6	Newport	Michigan	Ironwood	do	716,365
7	Norrie	do	do	do	698,345
8	Virginia	Minnesota	Virginia	do	673,583
9	Mahoning	do	Hibbing	do	611,592
10	Morris	do	do	do	528,169
11	Pioneer	do	Ely	do	525,045
12	Stevenson	do	Hibbing	do	496,785
13	Shenango	do	Chisholm	do	477,098
14	Chapin	Michigan	Iron Mountain	do	450,177
15	Spruce	Minnesota	Eveleth	do	441,437
16	Witherbee, Sherman & Co. (Mineville).	New York	Mineville	Magnetite	390,935
17	Pewabic	Michigan	Iron Mountain	Hematite	383,467
18	Lake Superior	do	Ishpeming	do	383,261
19	Lincoln	Minnesota	Virginia	do	380,501
20	Biwabik	do	Biwabik	do	370,584
21	Clark	do	Chisholm	do	356,830
22	Sunrise	Wyoming	Sunrise	do	354,012
23	Sellers	Minnesota	Hibbing	do	345,216
24	Cornwall	Pennsylvania	Cornwall	Magnetite	343,927
25	Cleveland Lake	Michigan	Ishpeming	Hematite	341,845
26	Gilbert	Minnesota	Sparta	do	340,695
27	Glen	do	Chisholm	do	295,966
28	Leetonia	do	Hibbing	do	289,896
29	Negaunee	Michigan	Negaunee	do	281,415
30	Monroe-Tener	Minnesota	Chisholm	do	281,248
31	Ashland	Michigan	Ironwood	do	274,008
32	Hartford	do	Negaunee	do	272,441
33	Aragon	do	Norway	do	248,954
34	Hawkins	Minnesota	Nashwauk	do	248,246
35	Chisholm	do	Chisholm	do	240,995
36	Lake Angeline	Michigan	Ishpeming	do	229,139
37	Miller	Minnesota	Aurora	do	221,000
38	Cliff Shaft	Michigan	Ishpeming	do	219,242
39	Aurora	do	Ironwood	do	219,198
40	Susquehanna	Minnesota	Hibbing	do	218,533
41	Penn Iron Mining Co	Michigan	Vulcan	do	214,883
42	Rust	Minnesota	Hibbing	do	212,840
43	Great Western	Michigan	Crystal Falls	do	209,154
44	Mountain Iron	Minnesota	Mountain Iron	do	206,698
45	Tobin	Michigan	Crystal Falls	do	200,307
46	Austin	do	Princeton	do	197,411
47	Crosby	Minnesota	Nashwauk	do	196,854
48	Bristol	Michigan	Crystal Falls	do	184,300
49	Montreal	Wisconsin	Hurley	do	178,330
50	Kinney	Minnesota	Kinney	do	177,612
51	Laura	do	Hibbing	do	174,956
52	Elba	do	McKinley	do	172,545
53	Greeley	Alabama	Greeley	Brown hematite.	167,655
54	Ironton	Michigan	Bessemer	Hematite	167,293
55	Agnew	Minnesota	Hibbing	do	164,633
56	Baltic	Michigan	Stambaugh	do	156,667
57	Myers	Minnesota	Chisholm	do	154,754
58	Iroquois	do	Mountain Iron	do	152,786
59	Croxton	do	Chisholm	do	151,210
60	Duluth	do	Biwabik	do	149,185
61	Hull	do	Hibbing	do	148,163
62	Sibley	do	Ely	do	144,559
63	Florence	Wisconsin	Florence	do	140,375
64	Mohawk	Minnesota	Aurora	do	137,715
65	Odanah	Wisconsin	Hurley	do	136,352
66	Brown Mining Co	Tennessee	Cardiff	do	131,513
67	Songo	Alabama	Redding	do	129,253
68	Eureka	Michigan	Ramsay	do	124,184

Iron-ore mines of the United States that produced more than 50,000 long tons each in 1908—Continued.

Rank.	Name of mine.	State.	Nearest town.	Variety of ore.	Quantity.
69	Queen Group	Michigan	Negaunee	Hematite	120,627
70	Princeton	do	Princeton	do	120,128
71	Sunday Lake	do	Wakefield	do	120,075
72	Jordan	Minnesota	Chisholm	do	118,529
73	Commodore	do	Virginia	do	116,112
74	Cyprus	do	Hibbing	do	115,745
75	Port Henry, No. 21	New York	Mineville	Magnetite	111,728
76	Zenith	Minnesota	Ely	Hematite	108,536
77	Republic	Michigan	Republic	do	107,595
78	Utica	Minnesota	Hibbing	do	105,972
79	Minorca	do	Virginia	do	103,704
80	Riverside	Georgia	Cartersville	Brown hematite.	100,000
81	Adriatic	Minnesota	Mesaba	Hematite	99,366
82	Salisbury	Michigan	Ishpeming	do	99,290
83	Caspian	do	Stambaugh	do	99,287
84	Hiawatha	do	Iron River	do	98,660
85	Cambria	do	Cambria	do	98,498
86	Brotherton	do	Wakefield	do	95,986
87	Fierro	New Mexico	Fierro	Magnetite	95,872
88	Maltha	Minnesota	Sparta	Hematite	95,711
89	Mary Charlotte	Michigan	Negaunee	do	93,117
90	Yates	Minnesota	Buhl	do	88,922
91	Moro	Michigan	Ishpeming	do	86,140
92	Colby	do	Bessemer	do	85,541
93	Stephenson	do	Princeton	do	85,051
94	Hemlock	do	Amasa	do	84,968
95	Richard	New Jersey	Wharton	Magnetite	84,684
96	Bessemer	Minnesota	Virginia	Hematite	84,654
97	Oriskany	Virginia	Oriskany	Brown hematite.	83,914
98	La Rue	Minnesota	Nashwauk	Hematite	79,313
99	Mikado	Michigan	Bessemer	do	78,852
100	Rolling Mill	do	Negaunee	do	75,786
101	Imperial	do	Michigamme	do	75,767
102	Dunn	do	Crystal Falls	do	75,494
103	Yawkey	Minnesota	Virginia	do	75,362
104	Corsica	do	McKinley	do	74,643
105	Bessemer, No. 3 Shaft	do	Virginia	do	73,247
106	Riverton	Michigan	Iron River	do	72,772
107	Mayville	Wisconsin	Mayville	do	71,341
108	Atlantic	do	Iron Belt	do	71,201
109	Valley View	Alabama	Birmingham	do	71,188
110	Youngs	Michigan	Palatka	do	70,093
111	Tilden	do	Bessemer	do	68,166
112	American	do	Ishpeming	do	66,719
113	Albany	Minnesota	Hibbing	do	65,940
114	Maas	Michigan	Negaunee	do	64,332
115	Troy	Minnesota	Eveleth	do	63,996
116	Winnifred	do	Hibbing	do	62,975
117	Pettit	do	Gilbert	do	61,852
118	Breitung Hematite, Mine No. 2.	Michigan	Negaunee	do	61,481
119	West Giles	Alabama	Woodstock	Brown hematite.	61,439
120	Ferro	Tennessee	Ferro	do	61,388
121	Ohio	Michigan	Michigamme	Hematite	61,035
122	Richmond	do	Negaunee	do	60,411
123	Pillsbury	Minnesota	Chisholm	do	59,889
124	Lyon Mountain	New York	Lyon Mountain	Magnetite	59,834
125	Anvil	Michigan	Bessemer	Hematite	58,579
126	Mansfield	do	Crystal Falls	do	56,117
127	Hartley	Minnesota	Chisholm	do	55,462
128	Savoy	do	Ely	do	55,374
129	James	Michigan	Iron River	do	55,274
130	Champion	do	Beacon	do	53,758
131	Iron Belt	Wisconsin	Iron Belt	do	53,308
132	Higgins	Minnesota	Virginia	do	53,085
133	School	Tennessee	Ducktown	Brown hematite.	51,363
134	Alberta	Minnesota	Virginia	Hematite	51,142
	Total (134 mines)				31,077,691
	Unspecified (16 mines)[a]				2,007,451
	Grand total				33,085,142

[a] Includes the product of 16 mines producing over 50,000 long tons each, operated by eight companies, which object to the publication of individual statistics.

STOCKS OF IRON ORE AT MINES.

Considerable stock was left at the mines at the end of 1908 which is not included in the production. On December 31, 1908, this stock amounted to 6,065,397 tons, as compared with 3,033,110 tons on December 31, 1907. Besides the stock at the mines, stocks are left at receiving ports, but these are included in the annual production.

The following table shows the tonnage of stock left at the mines on December 31, 1907 and 1908, in the various States:

Stock of iron ore on hand at the mines December 31, 1907 and 1908, by States, in long tons.

State.	1907.	1908.
Alabama	55,871	381,607
Colorado	.....	400
Georgia	.....	50,550
Kentucky	.....	600
Maryland	800	.....
Massachusetts	3,000	952
Michigan	1,546,946	3,280,659
Minnesota	1,095,789	1,737,568
Missouri	825	10,546
New Jersey	45,107	115,218
New York	47,675	118,415
Ohio	14,548	15,041
Pennsylvania	7,747	15,781
Tennessee	11,773	26,923
Texas	89,050	53,600
Utah	50	.....
Vermont	100	350
Virginia	3,231	8,823
Washington	.....	15,000
Wisconsin	110,598	233,364
Total	3,033,110	6,065,397
Percentage of increase in 1908	.....	99.97

PRICE OF IRON ORE PER TON.

In the following table, the price per ton of the different classes of iron ores is given for each of the producing States. These figures represent the value at the mines and are taken directly from statements of the producers. They should be accepted merely as fair approximation to the truth. The element of inaccuracy arises from the fact that by far the greater bulk of the iron ore produced in the United States is mined by pig-iron producers for their own furnaces, and the value placed on such ore is therefore entirely a matter of accounting. Some of the reports made to the Survey evidently include merely actual mining costs; others contain an allowance for sinking fund; and in still others the figures given are merely convenient prices to use in charging costs against the blast furnaces.

It is to be noted, however, that the errors are almost entirely in one direction—that of undervaluing the ore rather than of overvaluing it. If all the iron ore were to be bought by iron furnaces in open market from an entirely distinct set of iron-ore producers, the average prices paid would probably be considerably in excess of those now reported. It is of interest to compare the prices given below with those of the Lake Superior ores at the lower lake ports given in a subsequent table.

Average price per long ton of iron ore in the United States in 1908, by States and varieties.

State.	Hematite.	Brown ore.	Magnetite.	Carbonate.
Alabama	$1.10	$1.37	.....	.....
Arkansas and Texas	.....	[a] .55	.....	.....
Colorado	.....	1.81	.....	.....
Connecticut and Massachusetts	.....	3.75	.....	.....
Georgia	1.35	1.68	.....	.....
Kentucky, Maryland, and West Virginia	1.15	1.67	.....	.....
Michigan	2.85	.....	.....	.....
Minnesota	2.27	.....	.....	.....
Missouri	2.27	2.01	.....	.....
Montana, Nevada, New Mexico, Utah, and Wyoming	1.11	[b] 3.22	$1.00	.....
New Jersey	.....	3.35	2.94	.....
New York	1.97	.....	3.06	.....
North Carolina	.....	.....	1.58	.....
Ohio	.....	.....	.....	$1.38
Pennsylvania	2.05	2.36	1.01	.....
Tennessee	1.27	1.44	.....	.....
Virginia	2.04	2.13	2.00	.....
Wisconsin	2.77	2.00	.....	.....
Total average	2.32	1.70	2.40	1.38

[a] Texas alone.

[b] Washington included.

APPARENT ANNUAL IRON-ORE CONSUMPTION.

The following table includes data on certain factors from which an approximate estimate of the annual consumption of iron ore in the United States is deduced. The result is of course merely an approximation, for no data are available on certain factors which should enter into the final result. The elements accounted for in the table and estimate are (1) domestic iron-ore production; (2) stock of ore at mines; (3) imports of ore; (4) exports of ore; (5) stocks of ore at lake ports; (6) zinc residuum production.

Apparent consumption of iron ore in the United States, 1889–1908, in long tons.

Year.	Domestic iron ore produced.	Stocks of ore at mines.	Imports.	Exports.	Stocks of ore at lower lake ports. Dec. 1.	Zinc residuum.	Apparent consumption.
1889	14,518,041	2,256,973	853,573	.....	2,607,106	43,648	14,366,562
1890	16,036,043	2,000,000	1,246,830	.....	3,893,487	48,560	16,302,025
1891	14,591,178	2,450,279	912,864	.....	3,508,489	38,228	15,476,989
1892	16,296,666	2,911,740	806,585	.....	4,149,451	31,859	16,032,687
1893	11,587,629	3,526,161	526,951	.....	4,070,710	37,512	11,616,412
1894	11,879,679	3,236,198	167,307	.....	4,834,247	26,981	11,600,393
1895	15,957,614	2,976,494	524,153	.....	4,415,712	43,249	17,203,255
1896	16,005,449	3,405,302	682,806	.....	4,954,984	44,953	15,765,128
1897	17,518,046	3,098,287	489,970	.....	5,923,755	33,924	17,380,184
1898	19,433,716	2,846,457	187,208	.....	5,136,407	48,502	20,708,604
1899	24,683,173	2,320,278	674,082	40,665	5,530,283	65,010	25,513,903
1900	27,553,161	3,709,950	897,831	51,460	5,904,670	87,110	26,722,583
1901	28,887,479	4,239,823	966,950	64,703	5,859,663	52,311	29,357,171
1902	35,554,135	3,834,717	1,165,470	88,445	7,074,254	65,246	35,886,921
1903	35,019,308	6,297,888	980,440	80,611	6,371,085	73,264	34,232,399
1904	27,644,330	4,666,931	487,613	213,865	5,763,399	68,189	30,224,910
1905	42,526,133	3,812,281	845,651	208,017	6,438,967	90,289	43,433,138
1906	47,749,728	3,281,789	1,060,390	265,240	6,252,455	93,461	49,355,343
1907	51,720,619	3,033,110	1,229,168	278,208	7,385,728	93,413	51,880,398
1908	35,983,336	6,065,397	776,898	309,099	8,441,533	110,225	32,473,268

COMPARATIVE PRODUCTION OF IRON ORE AND PIG IRON.

Detailed data on the pig-iron production of the United States are presented on later pages of this report, but in the following table an interesting comparison is made between the annual production of iron ore and of pig iron.

Production of iron ore and pig iron in the United States, 1889–1908, in long tons.

Year.	Iron ore mined.	Pig iron produced.[a]	Year.	Iron ore mined.	Pig iron produced.[a]
1889	14,518,041	7,603,642	1899	24,683,173	13,620,703
1890	16,036,043	9,202,703	1900	27,553,161	13,789,242
1891	14,591,178	8,279,870	1901	28,887,479	15,878,354
1892	16,296,666	9,157,000	1902	35,554,135	17,821,307
1893	11,587,629	7,124,502	1903	35,019,308	18,009,252
1894	11,879,679	6,657,388	1904	27,644,330	16,497,033
1895	15,957,614	9,446,308	1905	42,526,133	22,992,380
1896	16,005,449	8,623,127	1906	47,749,728	25,307,191
1897	17,518,046	9,652,680	1907	51,720,619	25,781,361
1898	19,433,716	11,773,934	1908	35,983,336	15,936,018

[a] From annual reports of the American Iron and Steel Association.

IRON-ORE INDUSTRY IN THE LAKE SUPERIOR DISTRICT.

Production of iron ore in the Lake Superior district, by ranges.—The Lake Superior district includes the Vermilion, Mesabi, Cuyuna, Penokee-Gogebic, Marquette, and Menominee ranges in the States of Minnesota, Michigan, and Wisconsin. The Menominee range includes the Crystal Falls, Metropolitan, Iron River, and Florence areas; the Marquette range includes the Republic and Swanzy areas. The Baraboo and Iron Ridge areas of southern Wisconsin and the Spring Valley area of northwestern Wisconsin are frequently also included in the Lake Superior district. In the first group of ranges, the ore mined is almost entirely pre-Cambrian hematite associated with the Lake Superior iron-ore formation. The Baraboo ore is of the same nature, but the Iron Ridge ore is Clinton hematite, and the Spring Valley ore is brown ore.

In addition to these ranges, there are several iron-ore districts on the Canadian side of the Great Lakes, the principal ones of which are the Michipicoten, Animikie, Matawin, and Atikokan.

The American districts which produced ore in 1908 were the Vermilion, Mesabi, Penokee-Gogebic, Marquette, Menominee, Baraboo, and Spring Valley. The following table shows the production of the first five of these for 1907 and 1908, as they constitute the Lake Superior district proper.

Production of iron ore in the Lake Superior region in 1907–8, by ranges.

Range.	1907.	1908.	Increase (+) or decrease (−) in 1908.	Percentage of increase or decrease, 1908.	Percentage of total production in Lake Superior region.
	Long tons.	*Long tons.*	*Long tons.*		
Marquette (Michigan)	4,167,810	3,309,917	− 857,893	−20.58	11.78
Menominee (Michigan and Wisconsin)	4,779,592	2,904,011	− 1,875,581	−39.24	10.33
Gogebic (Michigan and Wisconsin)	3,609,519	3,241,931	− 367,588	−10.18	11.53
Vermilion (Minnesota)	1,724,217	927,206	− 797,011	−46.22	3.30
Mesabi (Minnesota)	27,245,441	17,725,014	− 9,520,427	−34.94	63.06
	41,526,579	28,108,079	−13,418,500	−32.31	100.00

The Mesabi range produced 63.06 per cent of the entire Lake Superior output and about one-half of the entire production of the United States. The Marquette, Penokee-Gogebic, and Menominee ranges are next in importance, each producing a little less than the State of Alabama, which is the next State in importance as a producer after Minnesota and Michigan. The Vermilion range, the last in importance of the five producing Lake Superior ranges, produced more ore than New York, which is fifth in importance as a producing State.

In the following table is shown the total production of the Lake Superior district by ranges The figures prior to 1872 were collected by A. P. Swineford, editor Marquette Mining Journal;[a] those for 1872 to 1877, inclusive, are from the Michigan Mineral Statistics; those from 1878 to 1888, inclusive, were collected by W. J. Stevens;[b] and the later figures were collected by the United States Geological Survey.

Production of Lake Superior iron ore, 1854–1908, by ranges, in long tons.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Total.
1854–1869	3,112,209					3,112,209
1870	859,507					859,507
1871	813,984					813,984
1872	948,553					948,553
1873	1,195,234					1,195,234
1874	899,934					899,934
1875	881,166					881,166
1876	993,311					993,311
1877	1,014,754	10,375				1,025,129
1878	1,033,082	78,028				1,111,110
1879	1,130,019	245,672				1,375,691
1880	1,384,010	524,735				1,908,745
1881	1,579,834	726,671				2,306,505
1882	1,829,394	1,136,018				2,965,412
1883	1,305,364	1,047,863				2,353,227
1884	1,559,912	895,634	1,022	62,122		2,518,690
1885	1,430,862	690,435	119,590	227,075		2,467,962
1886	1,627,383	880,006	756,237	307,948		3,571,574
1887	1,851,717	1,199,343	1,285,265	394,910		4,731,235
1888	1,918,672	1,191,097	1,433,689	511,953		5,055,411
1889	2,631,026	1,876,157	2,147,923	864,508		7,519,614
1890	2,863,848	2,274,192	2,914,081	891,910		8,944,031
1891	2,778,482	1,856,124	2,041,754	945,105		7,621,465
1892	2,848,552	2,402,195	3,058,176	1,226,220	29,245	9,564,388
1893	2,064,827	1,563,049	1,466,815	815,735	684,194	6,594,620
1894	1,935,379	1,255,255	1,523,451	1,055,229	1,913,234	7,682,548
1895	1,982,080	1,794,970	2,625,475	1,027,103	2,839,350	10,268,978
1896	2,418,846	1,763,235	2,100,398	1,200,907	3,082,973	10,566,359
1897	2,673,785	1,767,220	2,163,088	1,381,278	4,220,151	12,205,522
1898	2,987,930	2,275,664	2,552,205	1,125,538	4,837,971	13,779,308
1899	3,634,596	3,281,422	2,725,648	1,643,984	6,517,305	17,802,955
1900	3,945,068	3,680,738	3,104,033	1,675,949	8,158,450	20,564,238
1901	3,597,089	3,697,408	3,041,869	1,805,996	9,303,541	21,445,903
1902	3,734,712	4,421,250	3,683,792	2,057,532	13,080,118	26,977,404
1903	3,686,214	4,093,320	3,422,341	1,918,584	13,452,812	26,573,271
1904	2,465,448	2,871,130	2,132,898	1,056,430	11,672,405	20,198,311
1905	3,772,645	4,472,630	3,344,551	1,578,626	20,156,566	33,325,018
1906	4,070,914	4,962,357	3,484,023	1,794,186	23,564,891	37,876,371
1907	4,167,810	4,779,592	3,609,519	1,724,217	27,245,441	41,526,579
1908	3,309,917	2,904,011	3,241,931	927,206	17,725,014	28,108,079
	88,938,069	66,617,796	57,979,774	28,220,251	168,483,661	410,239,551

Shipments and receipts of Lake Superior ore.—During 1908, 26,014,987 long tons of iron ore were shipped from the Lake Superior district. Of this total 587,893 tons were shipped by rail, the remainder being Lake shipments. Details concerning the shipments and re-

[a] Mineral Resources U. S. for 1882, p. 116.
[b] Mineral Resources U. S. for 1891, p. 41.

ceipts of these ores are given in the following tables, which are taken from the Iron Trade Review:

Shipments of Lake Superior iron ore, 1903–1908, in long tons.[a]

Shipping port.	1903.	1904.	1905.	1906.	1907.	1908.
Two Harbors	5,120,656	4,566,542	7,779,850	8,180,125	8,188,906	5,702,237
Escanaba	4,277,561	3,644,267	5,307,938	5,851,050	5,761,988	3,351,502
Duluth	5,356,473	4,649,611	8,807,559	11,220,218	13,448,736	8,808,168
Ashland	2,822,915	2,288,400	3,485,344	3,388,106	3,436,867	2,513,670
Marquette	2,007,346	1,907,301	2,977,828	2,791,033	3,013,826	1,487,487
Superior	3,978,579	4,169,990	5,118,385	6,083,057	7,440,386	3,564,030
Gladstone	35,816	553	.....	.....	.....	.....
Total	23,599,346	21,226,664	33,476,904	37,513,589	41,290,709	25,427,094
All-rail shipments	659,164	622,737	907,212	1,052,173	975,959	587,893
Grand total	24,258,510	21,849,401	34,384,116	38,565,762	42,266,668	26,014,987

[a] Iron Trade Review, March 11, 1909, p. 492.

Iron-ore receipts at Lake Erie ports, 1903–1908, in long tons.[a]

Port.	1903.	1904.	1905.	1906.	1907.	1908.
Ashtabula, Ohio	4,242,160	3,639,250	6,373,779	6,833,352	7,521,859	3,012,064
Cleveland, Ohio	4,434,160	3,572,228	5,854,745	6,604,661	6,495,998	4,240,816
Conneaut, Ohio	3,903,937	4,083,655	5,327,552	5,432,370	5,875,937	4,798,631
Buffalo and Tonawanda, N. Y.	2,149,901	2,433,601	3,774,928	4,928,331	5,580,438	2,835,099
Erie, Pa	1,257,798	1,284,778	2,112,476	1,986,539	2,294,239	828,602
Fairport, Ohio	1,434,342	1,157,858	2,008,621	1,861,498	2,437,649	1,518,961
Toledo, Ohio	652,305	508,793	1,006,855	1,423,741	1,314,140	680,553
Lorain, Ohio	990,490	972,931	1,605,823	2,191,965	2,621,025	2,286,388
Huron, Ohio	486,106	231,364	825,278	778,453	971,430	213,377
Sandusky, Ohio	130,532	48,356	51,202	35,847	83,043	.....
	19,681,731	17,932,814	28,941,259	32,076,757	35,195,758	20,414,491

[a] Iron Trade Review, December 31, 1908, p. 1087.

The following table shows the total quantity of iron ore shipped from the Lake Superior district since 1854, the date of the opening of the Marquette range, the oldest of the Lake Superior ranges. This table gives the shipments as collected by the Iron Trade Review and is inserted for comparison with the table giving the total production of the Lake Superior district, without regard to shipments.

Shipments of iron ore from the Lake Superior region, 1854–1908, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1854	3,000	1873	1,162,458	1892	9,069,556
1855	1,449	1874	919,557	1893	6,060,492
1856	36,343	1875	891,257	1894	7,748,932
1857	25,646	1876	992,764	1895	10,429,037
1858	15,876	1877	1,015,087	1896	9,934,828
1859	68,832	1878	1,111,110	1897	12,469,638
1860	114,401	1879	1,375,691	1898	14,024,673
1861	49,909	1880	1,908,745	1899	18,251,804
1862	124,169	1881	2,306,505	1900	19,059,393
1863	203,055	1882	2,965,412	1901	20,589,237
1864	243,127	1883	2,353,288	1902	27,571,121
1865	236,208	1884	2,518,692	1903	24,289,878
1866	278,796	1885	2,466,372	1904	21,822,839
1867	473,567	1886	3,568,022	1905	34,384,116
1868	491,449	1887	4,730,577	1906	38,565,762
1869	617,444	1888	5,063,693	1907	42,266,668
1870	830,940	1889	7,292,754	1908	26,014,987
1871	779,607	1890	9,012,379		
1872	900,901	1891	7,062,233		

Stocks of iron ore at Lake Erie ports.—The stocks of iron ore at the Lake Erie ports at the close of navigation on December 31, 1908, exceeded those of the same date in 1907 by more than 1,000,000 tons. The 1907 stock itself exceeded the average stock for the five preceding years by about 1,000,000 tons.

The stock of ore on hand at the ports on May 1, 1909, was slightly less than that at the same date in 1908, thus showing the consumption of over 1,000,000 tons of ore during the intervening time in excess of the consumption during the same period in 1908.

The following tables, taken from the Iron Trade Review contain data as to the stock of iron ore on hand at the Lake Erie ports on December 31, 1908, and on May 1, 1909. For comparison the stocks of iron ore on similar dates for the five preceding years are given:

Stock of iron ore at lower lake ports, December 1, 1903–1908, in long tons.[a]

Port.	At close of navigation, December 1—					
	1903.	1904.	1905.	1906.	1907.	1908.
Ashtabula, Ohio	1,911,911	1,403,575	1,589,951	1,631,312	2,056,820	2,293,531
Cleveland, Ohio	1,337,750	1,237,033	1,330,619	1,224,606	1,281,335	1,458,392
Fairport, Ohio	845,946	660,420	759,961	590,783	523,981	835,821
Erie, Pa	657,409	583,439	564,961	552,631	652,219	730,530
Lorain, Ohio	288,581	299,504	271,695	336,321	366,271	426,274
Conneaut, Ohio	591,364	684,487	976,976	1,057,424	1,090,774	1,296,675
Toledo, Ohio	106,710	318,573	368,024	281,000	518,645	590,925
Huron, Ohio	253,249	182,495	208,023	245,499	415,730	458,158
Buffalo, N. Y	282,890	318,739	315,780	315,412	435,407	315,148
Sandusky, Ohio	95,275	75,134	52,977	17,467	44,546	36,079
	6,371,085	5,763,399	6,438,967	6,252,455	7,385,728	8,441,533

[a] Iron Trade Review, May 13, 1909, p. 891.

Stock of iron ore at lower lake ports, May 1, 1904–1909, in long tons.[a]

Port.	At opening of navigation, May 1—					
	1904.	1905.	1906.	1907.	1908.	1909.
Ashtabula, Ohio	1,559,028	623,451	462,564	568,485	1,799,454	1,392,430
Cleveland, Ohio	968,508	513,559	350,382	447,573	1,029,198	1,018,055
Fairport, Ohio	579,677	390,869	266,162	154,246	225,328	562,679
Erie, Pa	474,275	236,414	169,488	189,276	595,660	557,029
Lorain, Ohio	237,404	165,586	140,452	176,300	327,052	362,096
Conneaut, Ohio	128,018	96,295	148,528	139,853	462,392	497,203
Toledo, Ohio	160,216	71,642	52,550	147,397	217,788	380,675
Huron, Ohio	208,008	68,100	80,738	98,106	392,731	379,364
Buffalo, N. Y	150,106	61,271	90,906	50,313	388,441	189,209
Sandusky, Ohio	68,863	44,444	29,320	5,439	42,256	31,528
	4,534,103	2,271,631	1,791,090	1,976,988	5,480,300	5,370,268

[a] Iron Trade Review, May 13, 1909, p. 891.

Prices of Lake Superior iron ores.—In the following table are given the prices of Lake Superior iron ores at the lower lake ports during 1907 and 1908. A reduction in price took place on June 15, 1908, of $0.50 per ton for all classes of ore, which is still in effect.

The base for the Bessemer ores is a metallic iron content of 55 per cent; that of the non-Bessemer ores is a metallic iron content of 51.5 per cent.

Prices per long ton of Lake Superior iron ores at lower lake ports, 1907–8.

	1907.	1908.	
		Until June 15.	After June 15.
Old Range:			
Bessemer	$5.00	$5.00	$4.50
Non-Bessemer	4.20	4.20	3.70
Mesabi:			
Bessemer	4.75	4.75	4.25
Non-Bessemer	4.00	4.00	3.50

FOREIGN TRADE IN IRON ORES.

IMPORTS.

The quantity of iron ore imported into the United States during 1908 was less than the importation during any year since 1899, with the exception of the year 1904 when the imports dropped very low. About three-fourths of the imports were from Cuba, about one-sixth from Spain, and the bulk of the rest was from Newfoundland. The statistics with regard to imports are furnished by the Bureau of Statistics of the Department of Commerce and Labor.

In the following table are shown the imports of iron ore from the various countries from 1905 to 1908, inclusive:

Quantity and value of iron ores imported into the United States, 1905–1908, by countries, in long tons.

Country.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Cuba	539,935	$1,437,900	639,362	$2,178,997	657,133	$2,522,710	579,668	$1,756,091
Spain	191,861	366,436	171,870	418,922	296,318	760,801	126,074	331,070
French Africa	.....	.....	.....	.....	65,940	252,897	.....	.....
Greece	.....	.....	48,630	61,560	23,800	42,927	4,850	5,311
Newfoundland and Labrador	5,600	5,600	[a] 125,395	125,395	89,685	97,735	48,285	48,285
United Kingdom	408	2,396	231	1,955	5,765	16,491	2,028	32,027
Germany	1	42	1,084	8,949	273	2,096	602	4,052
Netherlands	.....	.....	50	474	500	3,673	.....	.....
Canada	104,096	240,303	57,890	100,125	26,878	51,328	5,013	16,321
Belgium	400	3,370	400	6,662	125	1,102	1	28
Norway	.....	.....	9,278	37,240	.....	.....	.....	.....
East Indies—British India	.....	.....	6,200	27,155	.....	.....	.....	.....
Other countries	3,350	6,114	.....	.....	62,751	185,723	10,377	31,063
	845,651	2,062,161	1,060,390	2,967,434	1,229,168	3,937,483	776,898	2,224,248

[a] Newfoundland only.

The following table shows the imports of iron ore into the United States from 1905 to 1908, inclusive, by ports of entry:

Quantity and value of iron ores imported into the United States, 1905–1908, by customs districts, in long tons.

Customs district.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Baltimore	504,618	$1,290,420	617,866	$1,937,610	639,602	$2,436,457	248,875	$844,436
Boston	268	1,261	159	1,218	479	2,071	21	61
Charleston					500	3,673	500	3,070
Fernandina			50	474				
New York	34,296	70,419	3,475	8,400	7,405	19,989	4,392	17,424
Perth Amboy			290	1,450			1,355	23,637
Philadelphia	201,853	455,342	383,651	914,242	554,104	1,422,503	516,619	1,318,182
Savannah					100	630		
Alaska			3	6				
Los Angeles			859	6,940			51	501
Puget Sound			9	77	1,976	6,365		
San Francisco	400	3,370	100	925	100	832	50	446
Buffalo Creek	9,468	21,715	124	280	172	96		
Champlain	20	30	55	140	5	20	10	30
Cuyahoga	57,446	132,127	46,630	83,418	18,866	33,393	1,712	3,030
Detroit	13,929	32,036	4,863	8,007				
Erie	18,846	44,484	2,152	3,827	5,400	9,558		
Miami							2,569	9,403
Niagara					292	652	23	40
Oswegatchie	18	36	41	42			23	60
Vermont	529	1,043	53	378	167	1,244	676	3,758
St. Louis							22	170
Genesee	3,840	8,832						
Richmond	120	1,046						
	845,651	2,062,161	1,060,390	2,967,434	1,229,168	3,937,483	776,898	2,224,248

In the following table is shown the importation of iron ore into the United States as far as has been recorded. Iron ore was imported from Europe in large quantities for the first time in 1879, most of the ore prior to that date coming from Canada.

Imports of iron ore into the United States, 1872–1908, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1872	23,733	1884	487,820	1897	489,970
1873	45,981	1885	390,786	1898	187,208
1874	57,987	1886	1,039,433	1899	674,082
1875	56,655	1887	1,194,301	1900	897,831
1876	17,284	1888	587,470	1901	966,950
1877	30,669	1889	853,573	1902	1,165,470
1878	28,212	1890	1,246,830	1903	980,440
1879 [a]	150,197	1891	912,864	1904	487,613
1879 [b]	284,141	1892	806,585	1905	845,651
1880	493,408	1893	526,951	1906	1,060,390
1881	782,887	1894	167,307	1907	1,229,168
1882	589,655	1895	524,153	1908	776,898
1883	490,875	1896	682,806		

[a] Fiscal years end. [b] Calendar years begin.

EXPORTS.

The quantity of iron ore exported from the United States in 1908 amounted to 309,099 long tons, a slight increase over iron-ore exports in 1907.

In the following table is shown the exportation of iron ores from the United States by customs districts from 1905 to 1908, inclusive. The data regarding exports are collected by the Bureau of Statistics, Department of Commerce and Labor.

Quantity and value of iron ores exported from the United States, 1905–1908, by customs districts, in long tons.

Customs district.	1905.		1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Newport News			171	$940	77	$419		
New York	200	$413	115	930				
Norfolk and Portsmouth					18	240		
Arizona					206	1,098		
Buffalo Creek	2,350	7,061					25	$140
Champlain	16,686	38,824	15,226	45,692	14,855	44,595	7,359	22,517
Detroit					4	47	4	46
Duluth	93,364	280,097	165,780	561,316	43,513	150,722	52,509	187,059
Huron	31	169	28	169				
Memphremagog			43	143				
Niagara					60	195	3,097	7,289
Superior	94,216	199,033	83,877	162,649	219,761	565,644	244,408	789,306
Vermont					114	462	1,697	6,567
Puget Sound	1,170	4,860						
	208,017	530,457	265,240	771,839	278,608	763,422	309,099	1,012,924

The quantity of iron ore exported from the United States, as far as has been recorded, is shown in the following table:

Exports of iron ore from the United States, 1899 to 1908.

1899	long tons	40,665	1904	long tons	213,865
1900	do	51,460	1905	do	208,017
1901	do	64,703	1906	do	265,240
1902	do	88,445	1907	do	278,208
1903	do	80,611	1908	do	309,099

IRON-ORE INDUSTRY OF CUBA.

The iron ores which have been mined in Cuba up to the present time consist largely of hematite and magnetite and are obtained near Santiago, in the Province of Oriente (Santiago). Recently large deposits of brown ore have been attracting considerable attention, especially those of the Mayari and Moa fields in Oriente Province and those of the Cubitas field in Camaguey Province. No ores of this type have been mined, however.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The statistics of the Cuban iron-ore production were collected by the United States Geological Survey.

Shipments of iron ore from mines in the province of Oriente (Santiago), 1884–1908, in long tons.

Year.	Juragua Iron Co. (Limited).	Sigua Iron Co.	Spanish-American Iron Co.	Cuban Steel Ore Co.	Total.
1884	25,295				25,295
1885	80,716				80,716
1886	112,074				112,074
1887	94,240				94,240
1888	206,061				206,061
1889	260,291				260,291
1890	363,842				363,842
1891	264,262				264,262
1892	335,236	6,418			341,654
1893	337,155	14,020			351,175
1894	156,826				156,826
1895	307,503		74,991		382,494
1896	298,885		114,110		412,995
1897	[a] 248,256		[b] 206,029		454,285
1898	83,696		84,643		168,339
1899	161,783		215,406		377,189
1900	154,871		292,001		446,872
1901	199,764		[c] 334,833	17,651	552,248
1902	221,039		455,105	23,590	699,734
1903	155,898		467,723		623,621
1904	31,162		356,111		387,273
1905	139,828		421,331		561,159
1906	133,379		507,195		640,574
1907	181,063		500,330		681,393
1908	366,580		452,854		819,434

[a] Of this quantity, 5,932 tons were sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons were sent to foreign ports.
[c] Of this quantity, 12,691 tons were sent to foreign ports.

WORLD'S PRODUCTION OF IRON ORE.

The latest available statistics with regard to the world's production of iron ore are shown in the following table. Of the figures in this table, those of the United States, Great Britain, Cuba, Canada, and Australia are in long tons; those of the other countries are in metric tons.

World's production of iron ore in 1906 and 1907, by countries.

Country.	1906.	1907.
	Tons.	*Tons.*
United States	47,749,728	51,720,619
Germany and Luxemburg	26,734,000	27,697,128
Great Britain	15,500,406	15,731,604
Spain	9,448,533	9,896,178
France	8,481,000	10,008,478
Russia	5,170,000	5,700,000
Sweden	4,503,000	4,480,070
Austria-Hungary	4,088,466	4,356,804
Canada, Newfoundland	951,752	887,321
Cuba	640,574	658,331
Algeria	780,000	973,445
Greece	680,620	768,863
Italy	405,000	517,952
Belgium	177,000	316,250
China	111,460	33,306
India	74,106	67,667
Japan		
Norway	109,259	140,804
Australia	34,001	3,000

OCCURRENCE OF IRON ORES IN THE UNITED STATES.

For purposes of description, the iron-ore deposits of the United States may be conveniently grouped into three districts—the eastern district, the central district, and the western district. The eastern district includes the northeastern and southeastern commercial districts, the central district includes the Mississippi Valley and Lake Superior districts, and the western district includes the Rocky Mountain and Pacific Slope districts.

The following descriptions are partly the result of personal observation and partly summarized from various reports. A bibliography of the principal articles on iron ores of the United States is given at the end of this report. Some of the descriptions of the western deposits were taken from unpublished notes kindly furnished the Survey by Mr. R. C. Hills and Mr. O. A. Hershey.

EASTERN DISTRICT.

The various classes of iron ores of the eastern district may be briefly grouped as follows:

Hematite:

Clinton fossil and oolitic hematite of central New York, central Pennsylvania, western and southwestern Virginia, northeastern Kentucky, eastern Tennessee, northwestern Georgia, and northeastern Alabama.

Cambrian specular hematite or gray ore in the Appalachian region of Virginia, Georgia, and Alabama.

Red hematite in the Grenville series in northwestern New York.

Specular hematite in the crystalline area of northern New Jersey, southeastern Pennsylvania, and the Piedmont region of Virginia, North Carolina, and South Carolina.

Red hematite in the Fernvale formation in north central Tennessee.

Brown ore:

Brown ore of the "mountain" and "valley" types in western New England, southeastern New York, and the eastern part of the Appalachian belt from New Jersey to Alabama.

Oriskany brown ore in central Pennsylvania, western Virginia, eastern West Virginia, northeastern Kentucky, and southern Ohio.

Mississippian brown ore in western Kentucky and Tennessee and northwestern Alabama.

Limonite gossan ore found in the crystalline areas locally from New England to Alabama.

Bog ore in various scattered localities.

Magnetite:

Nontitaniferous magnetite in the crystalline rocks of the Adirondacks, southeastern New York, northern New Jersey, southeastern Pennsylvania, and the Piedmont region of Virginia, North Carolina, and South Carolina.

Titaniferous magnetite in the basic rocks of the Adirondacks, northern Rhode Island, and western Virginia and North Carolina.

Contact magnetite of the Cornwall type in southeastern Pennsylvania.

Limestone magnetite of southwestern Virginia.

Iron carbonate:

Bedded iron carbonate, spathic ore and kidney ore in the "Coal Measures" of western Pennsylvania, eastern Ohio, western West Virginia, and northeastern Kentucky.

Iron carbonate in the sediments of the Coastal Plain in Maryland.

Iron carbonate associated with limestone magnetite in southwestern Virginia.

Iron sulphide:

Pyrite and pyrrhotite at various localities in the crystalline region from New England to Alabama.

Pyrite found locally in the Paleozoic sediments of the Appalachian region.

HEMATITE.

Clinton fossil and oolitic hematite.—Clinton hematite deposits occur in many places along the outcrop of the Clinton formation from New York to Alabama, but only locally are they of workable extent. The principal deposits are found in the following districts: (1) In west-central New York, extending in a narrow belt from Niagara Falls through Rochester, and south of Utica to the northeastern part of Otsego County; (2) in central Pennsylvania in numerour narrow belts; (3) in Alleghany County, Va.; (4) in a belt through Lee and Wise counties, Va., extending southwestward into the La Follette district, Tenn.; (5) in a series of narrow belts in the Chattanooga district in east-central and southeastern Tennessee, northwestern Georgia, and northeastern Alabama; (6) in the Birmingham district in north-central Alabama; and (7) in Bath County, Ky.

The deposits of the Birmingham district are by far the largest and most important, but small operations are carried on in each of the other districts. The Chattanooga district and the west-central New York district are second and third in importance.

The Clinton ore deposits are in the form of beds or lenses interbedded with sandstones and shales at various horizons in the Clinton formation. In many localities three or four beds are found, one above the other, and are often separated by many feet of sandstone and shale. The ore seams vary in thickness from a few inches to 40 feet, though as a rule they are under 10 feet. The thicker beds generally contain interbedded layers of sandstone or shale. Single ore seams extend for many miles along the outcrop. In New York the beds are nearly horizontal and can be mined a long distance from the outcrop by stripping. In the Appalachian region, however, they generally occur on the slopes of synclinal ridges, dipping at varying angles into the mountains, and are consequently mined mainly from underground workings. In a few places the ore beds occur near the summits of the ridges and dip with the slope of the mountain, in which case considerable quantities of ore may be mined by stripping.

In the Birmingham district four beds have been recognized and described, viz, Hickory Nut, Ida, Big, and Irondale seams. The following description of them is given by E. F. Burchard:[a]

Hickory Nut seam.—This seam comprises 3 to 5 feet of sandy ore or ferruginous sandstone characterized by a great abundance of *Pentamerus oblongus*, fossils which resemble hickory nuts incased in the partly open outer shucks. The ore is of too low grade to be worked at present. The seam is developed principally in the district between Birmingham and Bessemer, and where recognized it lies 12 to 20 feet above the next lower seam.

Ida seam.—This seam consists of 2 to 6 feet of rather siliceous ore, associated with 14 to 16 feet of ferruginous sandstone. Ore at this horizon is more continuous and extensive than at the horizon of the Hickory Nut seam. It has been recognized at many of the workings from Bald Eagle Gap beyond Clear Branch Gap. Where worked, the seam is in general from 3 to 5 feet thick, and soft ore only has been obtained from it in surface workings. Such ore carries from 35 to 44 per cent of metallic iron, with a corresponding range in silica of 45 to 32 per cent. The Ida seam occurs 35 to 50 feet above the top of the Big seam.

Big and Irondale seams.—These two ore beds are considered together, since they are very closely associated in space. The ore, however, is somewhat different in quality, and the seams are so sharply separated by their sandstone or shale that they may be mined independently.

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[a] Burchard, E. F. The Clinton or red ores of the Birmingham district, Alabama: Bull. U. S. Geol. Survey No. 315, 1907, pp. 139–141.

The thickness of the Big seam is variously estimated at 16 to 40 feet. It extends as a traceable unit on Red Mountain practically the whole length of the mining district. Notwithstanding the great thickness, there are rarely more than 10 to 12 feet of good ore in a single bench, and at most places only 7 to 10 feet are mined. Probably the maximum thickness is attained between Red Gap (near Irondale) and Bald Eagle, although for a mile southwest of Red Gap the bed remains nearly as thick. From northeast to southwest the total thickness of the ore-bearing sediments gradually decreases without, however, altering greatly the thickness of the workable portion. About the middle of the district the seam becomes separated into two benches, either by a well-defined parting along the bedding plane or by a shale bed—thin at first, but thickening gradually to the southwest. The middle of the Big seam is the workable part in the northeast end of the district, but the upper bench is of most importance throughout the rest of the area. In the southwest portion of the district the lower bench, which farther northeast is composed of ore that will in later years be mined, becomes a series of thin strata of lean ore and shale, and is consequently of no possible value; and finally the upper bench itself becomes shaly and carries only a very low-grade ore.

The Irondale seam is best developed on Red Mountain between Pilot Knob on the northeast and Lone Pine Gap on the southwest. Southwest of Lone Pine Gap the seam either consists of interbedded low-grade iron ore and shale, or else its identity is completely lost. Its soft ore, now nearly all mined out either by surface trenches or slopes, is the best in the district. Its hard ore is also of high grade, and hitherto has been for the most part held in reserve, since ore could be produced from the thicker Big seam at a lower cost per unit of iron.

According to texture the Clinton ores are of two varieties, viz: (1) fossil ore and (2) oolitic ore. The former consists of a mass of fossil fragments; the latter is made up of small, rounded, flat concretions. In places these two types occur in different parts of the same seam; at other places they are intermingled in the same ore specimens.

The Clinton ore is also divided into two classes as regards grade, viz: (1) Soft ore, and (2) hard ore. The soft ore is found along the outcrop of the ore seam and penetrates downward into it for varying distances, from a few inches to 400 feet, depending on the dip of the bed and the nature of the overlying material. It represents the weathered portion of the seam. The hard ore is found at depth after the soft ore has been penetrated, the contact between them being generally quite sharp. The hard ore is characterized by high percentage of lime and low percentage of silica and iron; the soft ore contains high percentage of iron and silica and little or no lime, the latter having been leached out by surface waters. The ore is uniformly high in phosphorus and is all of non-Bessemer grade. The following are typical analyses of Clinton ore from Alabama, showing the gradation from hard ore to soft ore:

Analyses of Clinton iron ore from Alabama.

	1.	2.	3.	4.
Fe	37.00	45.70	50.44	54.70
SiO_2	7.14	12.76	12.10	13.70
Al_2O_3	3.81	4.74	6.06	5.66
CaO	19.20	8.70	4.65	.50
Mn	.23	.19	.21	.23
S	.08	.08	.07	.08
P	.30	.49	.46	.10

The soft ore varies in color from yellowish red to dark red or almost black; the hard ore is generally deep red. Crystals of calcite are abundant in the hard ore and together with ferric oxide form the cementing material between the fossil fragments or oolites.

Cambrian specular hematite.—Cambrian specular hematite occurs in important deposits in but two localities in the Appalachian region, namely, in the Roanoke region in Virginia and in the Talladega district in eastern Alabama. There are small occurrences in northwestern Georgia. Both of the principal districts have been shipping small quantities of ore recently and the Roanoke region was a producer in 1908.

The specular ores are very similar in their occurrence to the Clinton ores, being in beds or lenses of varying thickness and wide horizontal extent. The layers are interbedded with schist, slate, sandstone, and sandy shale, and range in thickness up to about 20 feet. In the Roanoke region only one layer of importance occurs, though in the northern part a thin layer occurs directly underneath it. In the Talladega district there are apparently several layers. In both districts the associated rocks are much folded and faulted, so that in places there are several parallel exposures, and it is difficult to determine whether these are of the same layer or whether more than one layer occurs. The beds in general have a vertical or very steep dip and are mined by slopes and underground workings.

The ore is a siliceous hematite of low grade. In the southern localities it is of the gray, specular, micaceous variety, in places very siliceous; in Virginia it is siliceous, hard, red ore. It is uniformly high in silica and phosphorus, and nearly all is of non-Bessemer grade. The following table shows the range in composition of a number of specimens of specular hematite:

Average range in composition of Cambrian specular hematite.

Fe	30.00–50.00
SiO_2	15.00–35.00
P	.05– .60
S	.02– 1.00
Al_2O_3	2.00–10.00
Mn	.10– .60

Red hematite of northwestern New York.—The northern part of New York is occupied by a great mass of pre-Cambrian crystalline and metamorphic rocks surrounded by Cambrian and Ordovician sediments. The rocks composing this mass are of both sedimentary and igneous origin, the former being the older. The sedimentary rocks consist largely of limestone, schist, and gneiss with local areas of quartzite and amphibolite. They are grouped together under the name Grenville series. The igneous rocks consist of granite, syenite, gabbro, and anorthosite, which have been intruded into the sedimentary series. Besides these rocks there are considerable areas of gneiss of undetermined origin which have been called the Saranac formation. All these formations are cut by numerous diabase dikes.

The iron ores of the Adirondacks and northwestern New York all occur in this pre-Cambrian mass, the titaniferous magnetite deposits being associated with the anorthosite and gabbro intrusions; the nontitaniferous magnetite deposits with the gneisses (both those of the Grenville series and those of undetermined origin), schists, amphibolites, and occasionally crystalline limestones; and the red hematites with the crystalline limestones, schists, and gneisses of the Grenville series.

The hematite deposits are confined to the western border of the pre-Cambrian area in Jefferson and St. Lawrence counties. They

are irregular in shape and are found chiefly along zones of replacement at the contact of the crystalline limestone and schist and in places in the schist itself. The ores are largely soft, red hematite, with subordinate specular, and average between 48 and 53 per cent iron.

Associated with the ores is a so-called "serpentine rock" which bounds the deposits and occurs irregularly through them. It is greenish in color and of chloritic nature, and is probably an alteration product of the wall rocks formed by the ore-bearing solutions. The ore and gangue are enclosed by solid rock walls. The deposits have rough tabular forms but the ore body itself is very irregular due to the admixture of "serpentine" rock.

The principal red hematite mines are in a belt extending northeastward from Antwerp to a point near Gouverneur, but many outlying deposits occur.

Specular hematite in crystalline rocks.—The most common occurrence of specular hematite in crystalline rocks is in association with nontitaniferous magnetite deposits in schists and gneisses. It is usually present in insignificant quantities as compared with the magnetite. Locally, however, deposits occur in which specular hematite is the main constituent, and magnetite is present only in small quantities. Such deposits occur at a few places in southeastern Pennsylvania, in the James River valley northeast of Lynchburg, Va., and in the Cranberry and Kings Mountain districts, North Carolina. The ores are similar in occurrence to the nontitaniferous magnetite, but the deposits are usually small and unimportant.

Red hematite of the Fernvale formation.—Hard red hematite occurs as a surface deposit near Goodlettsville and Baker Station along the boundary of Davidson and Sumner counties, north of Nashville, Tenn. The deposits are known as "dyestone" and occur at the horizon of the Fernvale formation (Ordovician). The ores are in concentration deposits formed by the weathering of a ferruginous marble layer in the upper part of the Fernvale.[a] The bed has an average workable thickness of about 8 feet. The ore is highly calcareous.

BROWN ORE.

Mountain and valley brown ores.—The mountain and valley brown ores are distributed through the eastern part of the Appalachian region in a broad belt trending northeast-southwest and extending from western New England on the north through southeastern New York, eastern Pennsylvania, western Maryland and Virginia, eastern Tennessee, western North Carolina, and northwestern Georgia into Alabama. Throughout its extent, the belt occupies the western part of the Blue Ridge and Appalachian mountains and the eastern part of the Appalachian valley, being coextensive with the area of Cambrian sediments. The brown ore deposits occur scattered through this region at irregular intervals. Generally they are arranged into groups separated by stretches of barren or sparsely mineralized ground.

The following are the principal districts: (1) Western Massachusetts, northwestern Connecticut, and southeastern New York;

[a] Ulrich, E. O., and Bassler, R. S., Personal communication.

(2) northern New Jersey; (3) Northampton, Lehigh, and Berks counties, Pa.; (4) Cumberland, Franklin, and York counties, Pa.; (5) Blue Ridge district, Va.; (6) New River district, Va.; (7) Shady Valley, northeastern Tennessee; (8) Cartersville district, Ga.; (9) Cedartown—Rock Run district, Georgia and Alabama; (10) Anniston district, Ala., and (11) Woodstock district, Ala. Other localities of subordinate importance occur in intervening areas.

The mountain ores occupy the eastern portion of the Appalachian brown-ore belt, being located in general in the Blue Ridge or Appalachian mountains or very near their western foot. The valley ores are closely associated with the mountain ores, but commonly are west of them, though there is no sharp line of demarcation. They are found in the valley west of the foot of the mountains or in valleys between outlying ridges. Both mountain and valley ores occur throughout the Appalachian belt from New England to Alabama.

The mountain ores occur in relatively small discontinuous pockets in residual material above the Lower Cambrian quartzite at or near the contact with the overlying formation, generally a limestone, while the valley ores are found in more extensive though shallower pockets in residual material overlying the limestones above the quartzite. Mountain ores occur as veins, breccia, or replacement deposits in the solid quartzite, or in pockets in variegated residual clay and sand derived from it or from overlying formations. Locally they occur in later clay and sand of fluviatile origin. The deposits in residual material are by far the most abundant and characteristic, those in the solid quartzite being relatively rare. The valley ores occur as irregular masses, seams, and disseminated fragments scattered through dark-red residual clay forming a blanket over the uneven surface of the limestones.

The mountain and valley ore deposits show no great width or depth and are of a discontinuous nature. Single deposits consist of numerous small pockets ranging from a few feet to several hundred feet in extent and scattered irregularly through the clay. Individual pockets are soon exhausted and new ones found. The valley, or limestone, deposits are shallow, extending down to the irregular surface of the bed rock, which is rarely more than 50 feet in depth. Such deposits extend horizontally over wide areas and are mined from extensive shallow open cuts. The mountain ores are of smaller horizontal extent but of greater depth, having been worked to several hundred feet below the surface.

Mountain and valley ore deposits rarely reach a size of more than 500,000 tons; a deposit of average size contains 100,000 to 200,000 tons. The ratio of ore to clay and sand varies from 1 to 5 to 1 to 20 in different deposits or different parts of a single deposit. The ores consist of a mixture of limonite and göthite. The purer forms range up to 55 per cent in metallic iron, but the impurities are generally such that the average iron content of the ore shipped is only about 45 per cent. Phosphorus is generally present in such quantity as to make the ore of non-Bessemer grade. The valley ores are of higher grade than the mountain ores and contain fewer impurities. The impurities vary in different localities according to the associated rocks. They consist of fragments of quartzite or chert, sand grains, clay, or shaly material. Siliceous impurities, as well as phosphorus and manganese, are more abundant in the mountain ores than in the valley ores.

The following tables show the range in percentages of the principal constituents in the mountain and valley ores:

Average range in composition of mountain ore.

Fe	35.00–50.00
SiO_2	10.00–30.00
P	.10– 2.00
Mn	.50–10.00

Average range in composition of valley ore.

Fe	40.00–56.00
SiO_2	5.00–20.00
P	.05– .50
Mn	.30– 2.00

Oriskany brown ore.—The principal districts producing Oriskany brown ore are in Alleghany County, Va., and vicinity, and in central Pennsylvania. Small deposits occur in southwestern Virginia, in Bath County, Ky., and in Adams County, Ohio.

These deposits occur at a definite stratigraphical horizon, namely, that of the Lewistown limestone (Silurian) directly underneath the "Monterey" (Oriskany) sandstone, or, where this is absent, the Devonian shale.

The deposits occur locally along the outcrop of this formation as a replacement of the pure layers in its upper part. They are of considerable extent and depth and are composed of a group of more or less connected pockets arranged along the strike of the formation. A deposit may have a length of several miles, through which extent individual pockets may in places reach a width of 75 feet and a length of several hundred yards, while between them the ore may thin down to a foot or less in width, or disappear altogether for considerable distances. In some places the deposits have a consistent and regular width. The greatest depth at which Oriskany ores have been found is 600 feet, at which point they apparently grade into limestone. The foot wall of the ore is formed by clay with chert fragments or by cherty limestone, and the hanging wall consists of ferruginous "Monterey" (Oriskany) sandstone or, where this is absent, of blue clay derived from the Devonian shale. The deposits are made up of fairly solid masses of ore or of irregular fragments and seams of ore in clay. Much clay occurs throughout the ore horizon. In places a deposit is cut in two lengthwise by beds of chert or clay.

The Oriskany ore is similar to mountain ore in texture, is of approximately the same grade, and contains similar impurities. It has the advantage over mountain ore, however, in being found in large deposits rather than in small discontinuous pockets. The ore is all of non-Bessemer grade, contains considerable silica, and locally also manganese. Unreplaced chert fragments are quite abundant in places. Along the outcrop the ore is generally mined from open pits, but at depth inclines and drifts are used.

In the following table is given the average range in composition of the Oriskany ores:

Average range in composition of Oriskany brown ores.

Fe	37.00–50.00
SiO_2	10.00–25.00
P	.06– .50
Mn	.50– 4.00

Mississippian brown ore.—Brown ores associated with Mississippian limestone occur in the Russellville district in northwestern Alabama and in western Tennessee and Kentucky. The principal deposits occur in western Tennessee east of the Tennessee River, but the deposits at Russellville are also of considerable importance. The ores occur in residual and fluviatile clay, sand, and gravel on the uneven surface of the Mississippian limestone (Bangor limestone in the Russellville district and St. Louis limestone in western Tennessee). Burchard[a] gives the following description of the Russellville ores:

The ore occurs in irregular masses, bowlders, pebbles, sand, and as cementing material in beds of conglomerate. * * * The irregular masses of ore, as well as the loose deposits, are found in pockets of varying richness, separated by more or less barren material, either directly upon the Bangor limestone or within the overlying Lafayette formation. As has been stated, the surface of the Bangor limestone is irregular, and many of the ore deposits seem to have been segregated at places where this surface is most uneven. Hollows or depressions in the limestone appear to have been favorable places either for the precipitation of the ore or for the collection of ore débris that has been transported to the region by wave or stream action.

According to position, the ore may be divided into two types—(*a*) masses that lie directly on the Bangor limestone or on the clay residual from the limestone, and (*b*) loose ore that occurs higher up, mixed with the Lafayette loam. The ore of type *a* is the more limited in extent, but usually the richer of the two, as it contains gravel only in a few cavities or cracks within the mass. In places over this ore and at the base of the loose loam and gravel of the Lafayette there is a very hard pebbly conglomerate with siliceous iron-oxide cement. The ore is medium to dark brown in color, and may be granular and easily broken or may be hard and composed of large lumps cemented or welded together. Masses of ore commonly cover or surround a "clay horse" or "white horse," which is a thin reef or pinnacle of light-colored residual clay that grades into the argillaceous limestone below. The clay at a few places contains small amounts of fine-grained ore that may have been compressed into it. * * * At many places in the hollows of the limestone between the "white horses" the ore is found in solid masses locally 10 to 15 feet thick and containing but little foreign matter. Many bowlders and masses of the ore contain cavities that are partly or completely filled with a fine-grained white to yellow clay or powder, the condition of this filling depending on the quantity of moisture present.

Most of the ore of type *b* consists of pebbles and lumps, but it also occurs in fragments of all sizes, ranging from a coarse sand to bowlders a foot thick. The Lafayette loam in which this ore occurs commonly contains pebbles of fossiliferous chert and of pink quartz, and these in places enter into the recently cemented conglomerate that lies over the ore of class *a*. In certain places the pebbles of ore have been sorted and concentrated by nature so as to form huge placer deposits.

The relations of the two types of ore suggest that the ore *a* was accumulated in pre-Lafayette time, and that the ore *b* was derived from it mechanically in fragmentary form and worked up into the basal conglomerate and loose gravel of the Lafayette formation.

The following description of the ores at Nunnelly given by Hayes and Ulrich[b] is typical of the Tennessee region:

Large deposits of limonite or brown ore are found embedded in red clay (at Nunnelly). Some waterworn pebbles are found at the surface, sometimes cemented into a conglomerate by iron oxide. It appears probable, therefore, that the region has been covered by alluvial deposits, but that they have been almost entirely removed, and that the great depth of clay found associated with the iron is doubtless residual, being derived from the weathering of the St. Louis limestone. Abundant fragments of the chert associated with the clay and iron are proof of this origin. The iron occurs in irregular pockets, frequently in the form of geodes, which range in size from a few inches to several feet. The exact conditions under which these iron ores were segregated is not clearly understood. Evidently conditions at these particular points were favorable for the deposition of iron which replaced the limestone removed by solution.

[a] Burchard, E. F. The brown iron ores of the Russellville district, Ala.: Bull. U. S. Geol. Survey No. 315, 1907, pp. 154-155.

[b] Hayes, C. W., and Ulrich, E. O., Columbia folio (No. 95), Geol. Atlas U. S., U. S. Geol. Survey, 1903.

Limonite gossan ore.—Limonite gossan deposits resulting from the oxidation of pyrite and pyrrhotite veins are found locally in the crystalline areas of New England and in the Piedmont region. They have been worked principally in Virginia and North Carolina, forming the basis of the first iron industry in these States. At present only a few deposits of this type are being mined. Many have been exhausted, and some have been abandoned for more profitable fields.

Bog ore.—Bog ore occurs in superficial deposits in the crystalline areas of New England, southeastern New York, and in the Coastal Plain area in New Jersey and southward. These ores have been mined occasionally for fluxing purposes and for use in the steel industry, but they have never been of great commercial importance.

MAGNETITE.

Nontitaniferous magnetite.—Nontitaniferous magnetite deposits occur in the Adirondack region, in southeastern New York and northern New Jersey, in southeastern Pennsylvania, and at numerous localities in the Piedmont region of the Southern States. The Adirondack deposits occur in general in two areas: (1) Within the Lake Champlain basin east and northeast of the Adirondack Mountains, and (2) in St. Lawrence County west of the Adirondack Mountains. The Pennsylvania deposits are confined largely to Bucks, Lehigh, and Berks counties. The deposits in the Southern States may be grouped into several districts: (1) The southern Virginia district; (2) Ashe County, N. C.; (3) the Cranberry district, North Carolina; and (4) the Kings Mountain district, North Carolina. In all these districts the ores are similar in occurrence and are associated with the same types of rocks.

The Adirondack ores are associated with metamorphosed rocks of either sedimentary or undetermined origin. The sedimentary rocks are gneisses of varying composition, biotite and hornblende schists, amphibolite and locally crystalline limestones, all of the Grenville series. The rocks of undetermined origin are largely acidic, syenitic, and granitic gneisses of Saranac formation. The ores of northern New Jersey are found in gneisses of probable sedimentary origin and in associated crystalline limestone; those of Pennsylvania occur in gneisses and schists of varying composition. In Virginia the deposits occur in gneisses and crystalline limestones; farther south they are associated chiefly with gneisses and schists.

The Adirondack ores[a] occur in elongated deposits parallel to the structure of the rocks. The deposits are variously described as beds, lenses, or pods, according to their form and extent. At a few localities the deposits are irregular in form, but for the most part they have a much greater length and depth than width. They lie along the planes of foliation in the inclosing rocks and in many places conform minutely to the folding and other structures in these rocks. In places the deposits extend along the strike of the rocks for such distances that they are best described as beds; while elsewhere they are thick and short and roughly lens shaped. Again they are pod shaped, pitching at varying angles below the surface. The dip of the deposit is always the same as that of the structures in the inclosing

[a] Newland, D. H., and Kemp, J. F., Geology of the Adirondack magnetic iron ores: Bull. New York State Mus. No. 119, 1908.

rocks which is in general steep and in many places vertical. The width of the deposits varies from a few inches to 50 feet or more, the length varies up to 300 or 400 yards, and the depth may range above 500 feet. The ores range from pure magnetite, carrying 60 to 70 per cent metallic iron, to impure mixtures of magnetite with minerals composing the wall rock, such as quartz, feldspar, pyroxene, hornblende, etc. When ores contain less than 50 per cent iron they require concentration; when they contain less than 35 per cent they are not worked. The concentrates contain from 62 to 70 per cent metallic iron. The ores contain varying percentages of silica according to the amount of gangue material present. The phosphorus and sulphur vary in different deposits as well as in different parts of the same deposit. Sulphur is generally higher in the ores of the Grenville series on account of the presence of pyrite in these rocks. The phosphorus content ranges from 0.01 per cent for 65 per cent ores to about 2 or 3 per cent, as a result of which the ore is separated into three grades: (1) High-grade low phosphorus; (2) Bessemer; and (3) non-Bessemer. In general the ores which contain the greatest amount of gangue material are lowest in phosphorus.

The deposits of northern New Jersey occur either as layers or bands in the crystalline Franklin limestone or as interleaved layers in the associated gneisses. The following description of the deposits is given by Bayley.[a]

> The ore * * * consists of an intimate mixture of magnetite, hornblende, pyroxene, quartz, feldspar, biotite, apatite, sphene, and pyrite in varying proportions. Hornblende, pyroxene, and apatite are the most persistent of the components aside from magnetite, and quartz is common. Apatite is present as small green, gray, or brown granules, at some places in large quantity and at others in minute traces. Pyrite is almost universally present, but in much of the ore only sparingly. Some of it is in the form of veinlets which were formed after the magnetite. Calcite is locally present as a late introduction * * * in thin layers along fractures. Manganese has been found by almost all analyses of specimens. * * * The minerals associated with the magnetite in the ore are the same as those in the surrounding gneiss. * * * There is usually no sharp line of demarcation between the ore and the rock, the former passing into the latter by gradual diminution in the quantity of magnetite present. In some places, however, the line between the two is plainly marked and the rock beyond the line is almost entirely free from magnetite. Many seams and masses of rock (gneiss or pegmatite) are inclosed in the ore and in places are entirely surrounded by it. * * * Practically all of the rich ore bodies are distinctly pod-shaped lenses, with the longitudinal planes of the pods parallel to the dip of the foliation in the neighboring gneisses and their longer axes conforming with the pitch of the rock structure. Usually a number of these lenses lie one above another in the same plane, all pitching and dipping in the same direction. The pods are known as shoots and the comparatively barren rock between them as pinches. * * * The pinches, though poor in ore, are not entirely barren. In some veins the walls close in, reducing the width of the ore bodies to a few feet or even a few inches. More commonly, however, the space between the shoots is occupied by rocks, which in some places is a pegmatite full of magnetite, in others is country rock (gneiss) traversed by a few or many very narrow stringers of magnetite connecting the shoots with one another, and in still others is a mass of coarse hornblende crystals cut by tiny veinlets of ore running parallel with the general direction of the gneiss.

Titaniferous magnetite.—Large deposits of titaniferous magnetite occur in the Adirondack region, and minor deposits are known in northern Rhode Island and in the Piedmont region of Virginia and North Carolina. The largest of the Adirondack deposits are in the Lake Sanford district, and smaller ones occur in the Lake Champlain basin. In northern Rhode Island ore occurs at Iron Mine Hill near

[a] Bayley, W. S., Iron ore: Passaic folio (No. 157), Geol. Atlas U. S., U. S. Geol. Survey, 1908, pp. 23-25.

Woonsocket. The Virginia deposits occur in the eastern part of Page County and other localities along the Blue Ridge; the North Carolina deposits are found in the Greensboro district and in Ashe County.

The titaniferous magnetite deposits almost without exception are associated with basic igneous rocks of the gabbro-anorthosite group. In the Adirondacks the anorthosite was the earliest of the intrusive igneous rocks, followed immediately by the gabbro and later by the syenite and granite. The ores are associated largely with gabbro dikes and masses which occur at intervals in the anorthosite area, but several large deposits in the Lake Sanford district are inclosed directly in the anorthosite. The small deposits associated with gabbro dikes have a tabular form with the longer diameter parallel to the wall of the dike; the large bodies in the anorthosite are irregular in form and have ill-defined borders. The deposits are of approximately the same age as the inclosing rocks, and both are simply different phases of the same rock mass. The ore consists of magnetite and ilmenite, both of which occur in the gabbro and anorthosite as accessory minerals. The deposits are simply local segregations of these minerals formed during the cooling of the igneous mass; they grade from pure iron ore (magnetite and ilmenite) through a gabbro or anorthosite rich in magnetite and ilmenite to an ordinary gabbro or anorthosite carrying these minerals in minor quantities.

The richest titaniferous iron ores contain about 60 per cent iron, this being somewhat lower than the percentage of iron in the nontitaniferous ores. The titanic oxide (TiO_2) is rarely below 8 or 9 per cent, and for the majority of deposits averages 15 per cent. The variation in titanic oxide content is due to a variation in the relative amounts of ilmenite and magnetite in the ores.

The titaniferous iron ores of Page County, Va., occur in small irregular deposits in a basic syenite (unakite). They are impure, being mixed with considerable amounts of minerals composing the inclosing rock.

Contact magnetite.—Magnetite deposits of the Cornwall type are found only in southeastern Pennsylvania. The principal deposits occur near Boyertown and Reading, Berks County; Cornwall, Lebanon County; and Dillsburg, York County. Small deposits are found near Warwick, Chester County, and Hummelstown, Dauphin County.

The ores occur at the contact of intrusive masses of Triassic diabase where they have intruded replaceable sediments. The principal deposits occur along the northern edge of the Mesozoic Newark belt, where the diabase is intruded into limestones and limy shales of Cambro-Ordovician age, but locally small deposits are found at the contact of the intrusive masses with Triassic sandstones and shales. The York County and Warwick deposits lie in Mesozoic strata; the Cornwall deposit is situated at the top of "No. II" limestone of the Pennsylvania section just under "No. III" ("Hudson") shale; the other deposits occur near the base of "No. II" limestone.

The following description of the deposits is given by Spencer.[a]

The Cornwall type of iron ore is so called from the important Cornwall mine in Lebanon County, Pa. The ores are essentially magnetite, but they contain pyrite in

[a] Spencer, A. C., Magnetite deposits of the Cornwall type in Pennsylvania: Bull. U. S. Geol. Survey No. 359, 1908, p. 10.

amounts which make it necessary to roast them before they can be used in the blast furnace. Some specular hematite occurs in certain of the mines, but the amount of this mineral is relatively unimportant.

The ore occurs in large and small masses of varying form, either entirely inclosed by stratified sedimentary rocks or lying in such rocks where they come in contact with masses of intrusive diabase. The ore minerals appear to have been formed by more or less complete chemical substitution in the body of the rock, the portion of the rock not replaced constituting the principal gangue of the ore. Aside from the deposition of the iron minerals, the limy strata associated with the ore bodies show remarkably little metamorphism, and though a few characteristic minerals of contact metamorphism occur, they are so uncommon as to almost escape observation. The Cornwall mines have yielded more than 20,000,000 tons of ore from what is essentially a single great ore body, though it contains extensive partings of barren rock. The other deposits are all much smaller, though several of them are still of important size.

The iron content of these ores is extremely variable, but as the ore is mined probably averages not far from 45 per cent. Rather constant chemical characteristics are low phosphorus, high sulphur, silica, and lime and magnesia, and the presence of copper.

Limestone magnetite.—Limestone magnetite deposits are found near Big Stony Junction, Giles County, near Abingdon, Washington County, and elsewhere in southwestern Virginia.

The ore occurs in the upper formations of the Shenandoah group of limestones and in clays derived from them. The deposits are apparently small, though indications of ore are found over a wide area. The ore usually occurs in beds in the limestone and in lumps of a few pounds each in the clay. Iron carbonate superficially altered to limonite occurs in the limestone associated with the magnetite.

The ore consists of a mixture of magnetite and hematite and is of high grade, being very low in phosphorus. The iron content ranges up to 62 per cent or more; the phosphorus content is low.

IRON CARBONATE.

Iron carbonate of the "Coal Measures."—Bedded iron carbonate occurs in the coal horizons of the Carboniferous rocks in western Pennsylvania, northern West Virginia, eastern Ohio, and northeastern Kentucky. The mining of these ores was at one time an important industry, but has practically ceased except for small operations in southeastern Ohio.

The ores are carbonate of iron, spathic iron ore or siderite, except along the outcrop and for variable distances in, depending on the character of the overlying material, where they have altered to hydrous ferric oxide, limonite.

Carbonate ores occur in all the formations from upper Mississippian to Permian, but the most important commercial horizons are in the Pottsville and Alleghany formations of the lower part of the Pennsylvanian. The most important horizon is at the top of the Vanport or "Ferriferous" limestone in the lower part of the Alleghany formation. This ore is known as "buhrstone ore," and occurs throughout the region mentioned. Many other important horizons of varying horizontal extent exist.

The ores have been divided into four classes,[a] viz: (1) Limestone ores, (2) block ores, (3) kidney ores, and (4) black band ores.

(1) The limestone ores are those which occur upon or very near the top of a limestone stratum. There are several important hori-

[a] Phalen, W. C., Economic geology of the Kenova quadrangle, Kentucky, Ohio, and West Virginia: Bull. U. S. Geol. Survey No. 349, 1908, p. 122.

zons at which this ore occurs, but the most important is that just above the Vanport limestone. At this horizon ore occurs in many places in the Carboniferous area of Pennsylvania, Ohio, West Virginia, and Kentucky. The Vanport limestone ranges up to 8 or 10 feet in thickness, and the ore above it varies from a few inches to several feet in thickness. In some places extreme variations in thickness may occur in the ore bed in short distances, thus giving it a pockety character. Locally, either or both ore and limestone are absent over considerable areas. The ore is altered to limonite along the outcrop, and it is this portion chiefly which has been mined. The limonite is usually brown or red and dense and close grained. It is fine and uniformly rich in iron. Most of this ore has been removed. The carbonate ore is dense, close grained, and bluish or grayish in color. The metallic iron in the limonite ranges from 40 to 50 per cent; that in the carbonate from 25 to 40 per cent. Other limestone ores occur at several horizons, but they are much more limited in their extent, occurring only locally over small areas.

(2) The block ores are so called because they cleave into square or rectangular prisms when mined. They consist of carbonate, except at the outcrop, where they are altered to limonite. Most of the block ores are in the Pottsville formation and the lower part of the Alleghany, and they are best developed in the western part of the district. They are more persistent than the limestone ores, and individual beds retain uniform thickness over wider areas. The beds, however, differ greatly in regard to thickness and quality of ore, though as a rule they are leaner than the limestone ores. The chief impurity is sand. In general the thick beds contain a lower grade of ore than the thin beds.

(3) The kidney ore occurs in peculiar rounded masses in clay or shale. The deposits, though occurring at distinct stratigraphic horizions, are not in definite beds like the preceding, but are scattered through zones 3 to 6 feet in thickness. They are best developed in the Alleghany formation above the Vanport limestone. Like the preceding ores, they are altered to limonite along the outcrop. As regards grade these ores compare very favorably with the limestone and block ores.

(4) The black band ores include beds of carbonate of iron, which contain less or more bituminous and earthy matter. They generally occur interbedded with bituminous shale. The ore is carbonaceous siderite, occurring in layers a few inches in thickness interbedded with shale layers through a zone varying in thickness up to 10 or 15 feet. The ore is generally of a higher grade than the other carbonate ores.

Iron carbonate in sediments of the Coastal Plain.—Lenses and layers of iron carbonate in the form of kidneys occur interbedded with Cretaceous sediments of the Coastal Plain in Maryland, near Muirkirk, and other places between Baltimore and Washington. Considerable quantities of ore have been mined, but at present operations have been suspended.

Iron carbonate in limestone in southwestern Virginia.—A few small deposits of iron carbonate occur in the Chickamauga limestone in southwestern Virginia in association with limestone magnetite ores. They are altered near the surface to limonite.

IRON SULPHIDE.

Iron sulphides.—Both pyrite and pyrrhotite occur in many localities in the crystalline rocks of the Piedmont region, and pyrite alone is found locally in small deposits in Paleozoic limestone and quartzite. The deposits in the crystalline rocks are usually in veins; those in the sediments are usually disseminated. They give rise to limonite gossan deposits.

Iron sulphides are used in the manufacture of sulphuric acid and the iron oxide residue (blue billy) is frequently used in blast furnaces for the production of pig iron.

CENTRAL DISTRICT.

The iron ores of the central district may be classified as follows:

Hematite:
- Soft, hard, and specular hematite associated with the pre-Cambrian iron formations of the Marquette, Menominee, Penokee-Gogebic, Mesabi, Vermilion, Cuyuna, and Baraboo ranges, Lake Superior district.
- Specular hematite associated with porphyry in the Ozark region, southeastern Missouri.
- Specular hematite associated with Cambrian sandstone in the Ozark region.
- Clinton hematite in east-central Wisconsin and in Missouri.
- Red hematite in the Carboniferous rocks of central Missouri.

Brown ore:
- Brown iron ores of the Claiborne formation (Tertiary) in northeastern Texas and northwestern Louisiana.
- Brown iron ores of the Ozark region.
- Bog ore in central and northwestern Wisconsin.
- Limonite gossan associated with the lead and zinc deposits in Wisconsin, Illinois, and Iowa.

Magnetite:
- Magnetite formed by regional and contact metamorphism of the pre-Cambrian hematite deposits in the Marquette, Mesabi, and Gunflint ranges, Lake Superior district.
- Titaniferous magnetite in gabbro in northern Minnesota.

Iron carbonate:
- Iron carbonate and silicate composing the unaltered iron formation in the Lake Superior district.

Iron sulphide:
- Pyrite and marcasite associated with the lead and zinc deposits in Wisconsin, Illinois, and Iowa.

HEMATITE.

Lake Superior hematite.—The Lake Superior hematite deposits constitute by far the most important type of iron ore in the United States and yield about four-fifths of the total annual product. They are grouped into seven minor districts or ranges, viz: The (*a*) Vermilion, (*b*) Mesabi, and (*c*) Cuyuna ranges of northern Minnesota; the (*d*) Penokee-Gogebic, (*e*) Marquette (including the Republic and Swanzy areas), and (*f*) Menominee (including the Crystal Falls, Iron River, Metropolitan, and Florence areas) ranges of northern Michigan and Wisconsin, and the (*g*) Baraboo range of southern Wisconsin. Other districts with similar ore occur in Ontario and north and northeast of Lake Superior.

The rocks of the Lake Superior district range in age from Archean to Cambrian with the following succession:

Succession of rocks in Lake Superior iron-ore district.

Cambrian:
  Potsdam sandstone.
Algonkian:
  Keweenawan series (sediments, trap, gabbro, etc.).
  Huronian series:
    Upper Huronian quartzite, iron formation, and slate.
    Middle Huronian quartzite, iron formation, and slate.
    Lower Huronian quartzite, conglomerate, dolomite, slate, iron formation, and intrusives.
Archean:
  Laurentian series (granite, gneiss, and porphyry).
  Keewatin series (greenstone, basic schists, and iron formation).

Of these rocks only the upper and middle Huronian and the Keewatin contain productive iron-ore deposits.[a] Iron ores occur in the upper Huronian, in the Mesabi, Cuyuna, Penokee-Gogebic, and Menominee districts; in the middle Huronian, in the Baraboo district; in both the upper and the middle Huronian, in the Marquette district; and in the Keewatin, in the Vermilion district.

The iron ores are confined to the iron formations, in which they occur as local concentration deposits, resulting largely from the leaching out of silica from the iron formation, though partly from additional precipitation of iron oxide. The iron formations are bedded deposits consisting chiefly of a mixture of chert or quartz and ferric oxide segregated in bands or mingled irregularly. Banded iron formation which has become highly crystalline through metamorphism and in which the bands are bright red is known as jasper. The ordinary reddish-gray iron formation consisting of banded or irregularly intermingled chert and iron oxide is known as ferruginous chert; on the Mesabi range the local name "taconite" is applied to it. There are many other subordinate phases of the iron formations resulting from metamorphism or from an admixture with other sediments. Locally, masses of cherty iron carbonate and hydrous ferrous silicate (greenalite) occur, which are supposed to be remnants of the original form in which the iron formations were deposited. Greenalite is characteristic of the Mesabi district, and cherty iron carbonate occurs in all the other districts. The ferruginous chert was formed by the weathering of the iron carbonate and greenalite. Where the cherty iron carbonate has been altered by contact or regional metamorphism, local areas of amphibole-magnetite rocks occur. Where the ferruginous chert was metamorphosed, jasper is found. Frequently layers and lenses of slate are found interbedded with the iron formation, and these show all gradations to ferruginous chert. Paint rock, a decomposed slate deeply stained and impregnated with ferric oxide, is characteristic of many of the iron-ore deposits. It forms from slate lenses at the same time that the alteration of the surrounding iron formation to iron ore and ferruginous chert is taking place. The last and most important phase of the iron formation is the iron ore itself, which occurs locally along the outcrop of the iron formation where meteoric waters have had a chance to operate and where favorable conditions for concentration prevail.

The rocks have suffered folding, faulting, and metamorphism to varying degrees in the different ranges, and these have influenced

[a] Leith, C. K., A summary of Lake Superior geology with special reference to recent studies of the iron-bearing series: Bimo. Bull. Am. Inst. Min. Eng., No. 3, 1905, p. 453.

the form and character of the ore deposits, so that there is considerable variation in different districts and different parts of the same district.

(*a*) The Vermilion range is in northern Minnesota in the northern part of St. Louis and Lake counties. The principal ore deposits are in the vicinity of Tower and Ely, and occur in iron formation of Keewatin age. The rocks are intricately folded and intensely metamorphosed, so that the iron formation is largely altered to jasper. The country rock is for the most part greenstone in which the jasper is infolded in local synclinal basins or troughs, so that areally it occurs in small patches surrounded by greenstone. The ores are associated with the jasper in these troughs and generally have a foot wall of greenstone. They consist of dense, hard, blue or red hematite, often brecciated but rarely specular.

(*b*) The Mesabi range is in central St. Louis and southeastern Itasco counties, Minn. The principal ore deposits are in the vicinity of Mesaba, Colby, Biwabik, McKinley, Sparta, Eveleth, Virginia, Mountain Iron, Buhl, Chisholm, Hibbing, Stevenson, and Nashwauk. The rocks of this region have suffered less folding and metamorphism than those of the other ranges. They dip slightly to the southeast, so that the iron formation outcrops in a general northeast-southwest belt. There are minor transverse folds. Above the iron formation and to the south is a thick slate; underneath it is a thin quartzite underlain by granite or graywacke and slate of lower-middle Huronian age, the former composing the Giants range north of the district. The iron formation is largely ferruginous chert, but at the eastern end of the range a heavy gabbro formation has metamorphosed it to amphibole-magnetite rock.

The iron ores cover large areas along the outcrop of the iron formation and are irregular in their occurrence, though in general they are best developed and most abundant at the minor transverse folds. The deposits are very irregular in shape, frequently having big arms extending from the main deposits, and these in places connect with other deposits. They are of great horizontal extent as compared with their vertical extent, being usually not more than 200 feet in depth, while they may extend continuously in a horizontal direction for a mile or more. Mining is carried on largely in large, shallow, open pits, the ore being loaded with steam shovels directly on railway cars and shipped without concentration. There are a few underground mines, and here the mining is carried on either by milling or by the regular underground methods.

The ore is a soft porous brown, red, or blue hematite of high grade. It shows the layering of the original iron formation, and in places the ore layers can be traced directly into the iron formation bounding the deposit. The ore layers generally show a slumping near the contact, showing that material has been leached from the iron formation during the process of ore concentration. In many instances ore bodies are bounded by joint planes. The following description of the factors controlling the ore deposition on the Mesabi range is given by Leith:[a]

> The agent of the alteration is water, coming more or less directly from the surface, carrying oxygen and carbon dioxide. The concentration of the ores has been found to occur where such waters have been converged. Various factors have determined this convergence—fracturing and brecciation of the iron formation, existence of

[a] Op. cit., pp. 485, 488, 489.

impervious layers in such attitudes as either to converge waters coming from above or to impound the waters and deflect their course between two layers. * * * The iron formation and its associated rocks lie in beds on the south slope of the Giants range, and dip off gently to the south at angles averaging from 8° to 10°. In addition to the general southward tilting of the beds, they are gently flexed into folds with axes transverse to the trend of the range. Waters falling on the south slope of the Giants range, and flowing to the south, enter the eroded edges of the iron formation and continue their way down along its layers, some of which are pervious and some of which are slaty and comparatively impervious to water. The flow thus tends to become concentrated along the axes of the synclines which pitch gently to the southward. Such synclines are not necessarily surface troughs. They are evidenced by the attitude of the layers of the iron formation, and may not be apparent in the unequally eroded rock surface or at the surface of the irregular covering of glacial drift. * * * Further study shows that other factors modify the circulation of water and the localization of the ore, and that these secondary factors may be locally dominant.

The most important of these modifying factors is the fracturing of the iron formation which has furnished numerous trunk channels for the circulation of underground waters. The water has been confined to narrow, irregular, and most devious trunk channels formed by the fracturing of the iron formation, and while it has probably followed the fracture openings along synclines to a greater extent than along anticlines, it has not filled the entire syncline formed by the folding of the iron formation. The result is that the ores have developed along limited and irregular areas within the synclines. They may occupy a considerable part of the syncline, in which case the synclinal structure of the iron formation may be observed in the layers of wall rock adjacent to the ores. In other cases they occupy so small a proportion of the syncline that the layers of the iron formation in the adjacent wall rock give no indication of synclinal dips. Not infrequently several more or less independent deposits may have developed in the same general syncline, as, for instance, in the area adjacent to the town of Virginia. To put it briefly, the ores show such a position, irregularity, extent, and relations to wall rocks as to make applicable the expression sometimes heard in the district that the ores have developed through the "rotting" of the iron formation along fractures, usually, but not always, in broad synclinal areas.

Other factors modifying the general underground flow of water in the Mesabi iron formation are the numerous impervious slaty layers within the iron formation, and the Virginia slate capping the iron formation of the south; all of which have considerable effect in directing water circulation. So far as the water is free to flow southward through the iron formation, the impervious layers serve only to limit the flow below. But the continuous south dip of the impervious strata carries the waters down to a point where the ground is saturated and the waters are ponded between impervious layers above and below. That ponding actually occurs is shown by the fact that drill holes penetrating the slates and entering the iron formation frequently meet water under pressure, indicating artesian conditions. When ponded, the water seeks the lowest point of escape, which is likely to be found near the north margin of the slate layers. The movement of the water toward the lowest point of escape causes a considerable lateral movement in the circulation, and this lateral movement has probably, at least in part, controlled the shape of certain deposits on the range which have their longer dimensions parallel to the strike of the layers of the iron formation.

The ponding of the water and consequent overflow has still another effect. Where ponded the flow is governed by the point of lowest escape rather than by the shape of the impervious basement. When water is drawn off at the edge of a basin, the flow is greatest near the point of escape and diminishes in all directions away from that point. This statement is true where the bottom of the basin is flat or fluted; hence, in the Mesabi iron formation, where the water is ponded, the flow is concentrated near the point of lowest escape regardless of whether this be over a syncline or anticline so far as both are below water level. The lowest point of escape is likely to be over synclines, but the surface erosion, both by glacial and meteoric agencies, has been such that this is not always the case. For this reason it is not certain that iron-ore deposits near the edge of the Virginia slate or near the edge of the interstratified slate layers may not have developed along arches as well as in synclines of the iron formation.

The above facts are intimately related to the problem of finding ore under the solid black Virginia slate. The question is frequently asked, Is there any reason why ore shall not be found under the black slate? The absence of ore under the slate has not been demonstrated by actual drilling; only a comparatively few holes have penetrated any considerable thickness of the Virginia slate and entered the iron formation below. Yet such holes as have been put down have revealed ore only near the slate margin and frequently of low grade. In several cases the iron formation beneath the slate

has been shown to be of a green, unaltered variety, indicating that the alteration necessary for the development of ore deposits has not gone far. If the development of the ore is dependent upon a vigorous circulation and this vigorous circulation is lacking under the Virginia slate because of the ponding, we have here an adequate cause for the nonexistence of ore deposits under the black slate. Yet further work may show that other factors have entered, and, considering the extent and value of the new iron-bearing territory which would be thrown open were ore found under the Virginia slate, more actual drilling seems advisable to settle the question.

(*c*) The Cuyuna district extends in a northeast-southwest direction along the Northern Pacific Railway in the vicinity of Aitkin, Deerwood, and Brainerd, in Crow Wing, Aitkin, and Morrison counties, central Minnesota. Geologically the district is situated along a series of minor northeast-southwest anticlines in the broad synclinal basin, on the northern limb of which is the Mesabi district and on the southern limb the Penokee-Gogebic district. The first ore was discovered here in 1904 by drilling along a line of magnetic attraction near Deerwood. No ore has been shipped from this district. Leith gives the following description of the geology and structure of the district:[a]

From the information so far available, consisting largely of drill samples, the succession of rocks for the Cuyuna district, from the base upward, is as follows:

Quartzite and its altered equivalents, quartzose, micaceous and hornblende schists.

Iron formation, consisting principally of iron carbonate where unaltered, but largely altered to amphibole-magnetite rock, ferruginous slates, and iron ore. The ores thus far found are soft, reddish, slightly hydrated hematite, reddish slaty hematite, and hard blue, banded, siliceous magnetite and hematite.

Chloritic and carbonaceous slate, interbedded in its lower part with iron formation.

Intrusive granite and diorite, principally the latter.

Cretaceous sediments.

Glacial drift, 80 to 350 feet.

It is possible that some of the igneous rock is really older than the sedimentary series, and lies unconformably beneath it, but no evidence of this has yet been found and the structural relations do not favor this view.

So far as the sedimentary rocks go, the emphasis should be placed on the altered phases, for they have all been much metamorphosed. Failure to recognize the schists as parts of the sedimentary series has caused confusion in the local interpretation of drill records. The changes in the quartzite and slate to schists are the typical anamorphic changes of the zone of rock flowage. When subsequently exposed at the surface, there has been a leaching out of all of the basic constituents, leaving light-colored, soft, kaolinic and quartzose schists. This action is most conspicuous in their upper 15 or 20 feet. The iron formation, originally mainly iron carbonate, has also undergone anamorphism, resulting in the development of amphibole-magnetite rocks essentially similar to amphibole-magnetite rocks wherever they are found in other parts of the Lake Superior region. This action, however, was not sufficiently effective to destroy a large part of the iron carbonate constituting the original mass of the formation. When exposed to weathering, the amphibole-magnetite rocks have remained substantially as they were, being very resistant, although becoming somewhat softer. The iron carbonate has been altered to iron ore. The gradation phases between the iron carbonate and slate have become ferruginous slates.

The anamorphism of the Cuyuna series is probably to be explained in large part by the existence of intrusives in the area itself and to the west and south of it.

The sedimentary series has been folded into a series of repeated folds, as shown by drilling and magnetic work, and erosion has cut off the top of the anticlines, exposing the iron formation in a number of belts, in general parallel, but presumably coming together at the ends of the folds. The dips are thus for the most part high, in the neighborhood of 80°, although near the crests of the folds they are less. The folding has been accompanied by the development of cleavage in the softer layers, especially in the softer slates. Where the cleavage can be definitely distinguished from the bedding,

[a] Leith, C. K., The geology of the Cuyuna iron range, Minnesota: Econ. Geology, vol. 2, p. 145.

there is usually a slight angle between them, and the cleavage has the steeper dip. The iron formation itself is less affected by the cleavage than the slate.

The ores constitute the altered and concentrated upper parts of the steeply dipping iron formation strata exposed by the erosion of the anticlines. The hanging wall is commonly chloritic slate and iron carbonate in varying proportions and degrees of alteration; the foot wall is either a quartz schist or amphibole-magnetite schist. Intrusives complicate these relations in many deposits, suggesting that the presence of these rocks has favored the development of the ore deposits. This is yet to be proved.

The ore bodies thus far found seem to be in the form of lenses 1 to 250 feet in thickness, with their longer dimensions parallel to the highly tilted bedding of the series. It is probable that also several parallel or overlapping lenses may be present, judging from analogy with the lower part of the Animikie series elsewhere in the Lake Superior region, as in the Paint River, Crystal Falls, and western Menominee country. Along the strike these lenses pinch out or widen, the change often being accompanied by a change in grade of the ore. It is difficult to tell from the present state of exploration just how far the parallel lenses are independent lenses in the same general formation and how far they may be the result of duplication by folding. The broader features of distribution are undoubtedly to be explained by folding. There is a narrow zone of iron formation extending from east of Aitkin southwest past Deerwood and Brainerd and for some distance west of the Mississippi River, as shown by magnetic attractions and by drilling. This is made up of a large number of short parallel and overlapping belts. Whether these minor belts are repeated by folding or whether they are parallel, independent lenses is not known. Six miles to the north, however, in the vicinity of Rabbit Lake, there is again a belt of iron formation which is undoubtedly brought up here by folding, for if it were an independent belt in a monoclinal succession it would imply too great a thickness of intervening strata. Still farther to the northwest between Rabbit Lake and Mississippi River are at least two more belts of iron formation repeated by folding. Whether the folds reappear again elsewhere, prospectors are now trying to determine.

The rock surface beneath the drift shows local variations of 100 feet or more, and between widely separated points, because of the general slope of the surface, may show a difference of elevation of as much as 250 feet. Frequently the soft hanging-wall slates are found to be at lower elevations, because of erosion, than the harder iron formation or the foot-wall quartzite adjacent, as, for instance, near Pickands, Mather & Co.'s shaft in sec. 8, 45–29. Notwithstanding these local irregularities of the surface, it is, in a broad way, relatively flat. At many places in the district and in adjacent parts of Minnesota Cretaceous deposits are found just above the rock surface and beneath the drift, suggesting that this flat surface may be part of a pre-Cretaceous base level or peneplain. The Cuyuna district contrasts in topography of the rock surface with the producing ranges of the Lake Superior region, where there is usually a marked ridge or range giving a head to the percolating surface waters of from 200 to 500 feet and making it possible for the waters to circulate vigorously and accomplish ore concentration to considerable depths where structural conditions allow. This suggests the inference that in the Cuyuna district vigorously circulating ore-concentrating waters may not have been effective to so great a depth as in other Lake Superior iron ranges. On the other hand, if the ores were developed before the base level and before reaching the present base level, there may have been greater topographic relief, which would have aided the alteration of the rocks and concentration of the ore to a greater depth than would the present relief. The existence of the heavy mantle of weathered material over the area may represent a remnant of the weathered material which in the other districts has been removed by glacial erosion. It is obvious that the Cuyuna district has been one in which glacial deposition has predominated over glacial erosion. When it is remembered that in the other Lake Superior districts glacial erosion has probably removed large amounts of iron ore, the lack of glacial erosion in the Cuyuna district may not be an unfavorable indication.

(*d*) The Penokee-Gogebic range is in northern Michigan and Wisconsin, crossing the boundary in a northeast-southwest direction at Ironwood. The principal mines are at Hurley, Wis., and at Ironwood, Wakefield, and Bessemer, Mich.

The ores occur in iron formation of upper Huronian age which is overlain by slate and underlain by quartzite and black slate. Above the upper slate is a heavy gabbro of Keweenawan age, which in a few localities has come into contact with the iron formation and has metamorphosed it to jasper and amphibole-magnetite rock. For the

most part, however, the iron formation is ferruginous chert. The sedimentary rocks dip steeply to the northwest. They are cut by dikes of basic igneous rocks of probable Keweenawan age, which cross them at varying angles to the bedding. The ores are concentrated in large irregular bodies in the angles between the foot-wall quartzite or black slate and the igneous dikes. These two formations make an impervious trough toward which underground channels for meteoric waters converge and in which the waters are ponded and precipitate their load. The deposits are of a different form and character from those of the Mesabi range. Most of them reach depths of a thousand feet and upward, but their horizontal extent is very much smaller than that of the deposits of the Mesabi range. The ore is for the most part soft hydrated hematite, but hard slaty ore is abundant, and more rarely needle ore is found. In a few deposits local pockets of manganese oxide occur. Mining is carried on by underground methods entirely.

(*e*) The Marquette range, including the Republic and Swanzy areas, occupies a large east and west elongated area west and southwest of Marquette, Mich. The principal mines are in the vicinity of Michigamme, Negaunee, Ishpeming, Swanzy, and Republic. Iron formations occur in both the upper and middle Huronian, the latter containing the principal ores. The iron formation of the upper Huronian is underlain by quartzite and overlain by slate. Ores occur locally as concentration deposits in the lower part of the iron formation and in other places as detrital deposits at the base of the quartzite underlying it. The latter type of ore is derived from deposits in the underlying iron formation occurring at the top of the middle Huronian. The middle Huronian iron formation (Negaunee) is underlain by slate, which in turn is underlain by quartzite. The sedimentary rocks are abundantly intruded by dikes, bosses, and stocks of basic igneous rock of probable Keweenawan age.

The sediments are folded into a great east-west synclinal basin composed of a number of minor synclines and anticlines. Ores occur on both limbs of the basin, but are most abundant on the north limb. The deposits near Ishpeming and Negaunee occur in a part of the basin where the upper Huronian rocks have been eroded away and the middle Huronian iron formation is exposed over the entire width of the basin. The deposits near Republic are in a minor syncline branching southeastward from the western part of the main basin. The Swanzy area is southeast of the main basin.

The ores of the middle Huronian and the detrital ores at the base of the upper Huronian occur at nearly the same geologic horizon, and the latter are derived from the former. The ores may be divided into three classes:[a] (1) Ores at the base of the iron-bearing Negaunee (middle Huronian) formation; (2) ores within the Negaunee formation; and (3) detrital ores at the base of the Goodrich (upper Huronian) quartzite.

(1) The ores of this class occur only at the base of the Negaunee formation, and, therefore, at the outskirts of the iron formation areas. They occur at places where the underlying slate has been folded so as to form pitching synclinal basins. In these impervious troughs the ore deposits have developed. In many places basic dikes have cut

[a] Van Hise, C. R., The iron-ore deposits of the Lake Superior region: Twenty-first Ann. Rept. U. S. Geol Survey, pt. 3, 1901, p. 305.

the rocks, and the ore has developed between the dikes and the slate, thus presenting a similarity to the deposits of the Penokee-Gogebic district.

(2) The ores of the second class are developed at the contact of the iron formation with basic intrusions. They occur either in local irregularities (basins) on the surface of the intrusive masses or in pitching troughs formed between igneous masses and dikes branching out from them. The surfaces of the igneous masses are very much altered, leached out, and impregnated with iron oxide, being changed largely to soapstone and paint rock. Many of the dikes are entirely altered.

(3) The detrital ores were formed by the breaking up of the deposits of types (1) and (2) during the erosional period intervening between the deposition of the middle and upper Huronian. These deposits are also localized by pitching troughs in the basic intrusions, between dikes and intrusive masses or slate layers, as are the lower ores. They may rest on a basement of soapstone (altered igneous rock), iron formation, or slate.

The ore of classes (1) and (2) are chiefly soft hydrated hematite; those of class (3) are hard, specular ores with some magnetite. The metamorphism of class (3) is apparently due to greater movement along the contact of the middle and upper Huronian during the folding than within these rocks themselves. With the hard ore are developed jasper and amphibole-magnetite rock.

(f) The Menominee range, including the Crystal Falls, Iron River, Metropolitan, and Florence areas, is in Dickinson and Iron counties, Mich., and extends across the boundary into Florence County, Wis. The principal mines occur at Iron Mountain, Norway, Metropolitan, Crystal Falls, Amasa, and Iron River, Mich., and at Florence, Wis.

Iron formations are found in both the upper and middle Huronian, but only the former carry iron ores of commercial importance. The middle Huronian iron formation is found only in the northern part of the district, while the upper Huronian iron formation occurs in the southern part of the district. Thus the productive areas are confined to the southern part.

The upper Huronian iron formation is known as the Vulcan formation in the Menominee district proper. The rocks are intricately folded so that the structure of the range is very complicated. The ores of the different areas occur in separate local basins or structural units.

The Vulcan formation in the Menominee district proper is divided into three members, viz: The Curry iron-bearing member, the Brier slate member, and the Traders iron-bearing member. It is overlain by upper Huronian (Hanbury) slate and underlain by lower Huronian (Randville) dolomite. Iron ores may occur at any horizon within the ore-bearing members, but are more prevalent at the top or bottom. The deposits are of large size and occur on relatively impervious formations which are usually folded into pitching troughs at the places where the ores are found. Pitching troughs may be formed (1) by the dolomite underlying the Traders member, (2) by a slate layer constituting the lower part of the Traders member, and (3) by the Brier slate underlying the Curry member.

The sedimentary formations are folded into two major anticlines trending a little north of west so that the iron formation is distributed in several belts, along which ore deposits occur locally. Minor folds

are superimposed on the major folds. The sediments are bounded on the north by Archean granite and on the south by Archean (Quinnesec) schist.

The iron ores are principally gray, finely banded hematite with subordinate amounts of flinty block hematite locally banded.

The iron-bearing formation in the outlying areas consists mainly of ferruginous slates and cherts with some cherty iron carbonate. The former are generally carbonaceous immediately above and below the ore-bearing beds. The formation is underlain by slate, which is in turn underlain by lower Huronian formations. Above the iron formation is the Michigamme slate. In some of the outlying areas the iron formation and the underlying slate have not been separated from the Michigamme slate.

In general the ores occur in pitching synclinal basins bottomed and capped by slate layers. They are largely soft red hematite, considerably hydrated in places.

(*g*) The Baraboo range is located in southern Wisconsin in the central part of Sauk County. The principal deposits occur near the town of North Freedom.

The Huronian rocks are in the form of an east and west elongated syncline surrounded by Cambrian sandstone and containing a considerable thickness of Cambrian sandstone within it. Thus only the rim of the syncline consisting of heavy bedded quartzite is exposed. This quartzite forms the base of the series and rests on Archean rock. Above it is the Seeley slate and above this the iron formation which carries the ores of the district. The iron formation is overlain by the Freedom dolomite. The rocks of the iron formation immediately associated with the ores are ferruginous dolomite, ferruginous chert, and ferruginous slate.

The principal workable deposits have been found in the southwestern portion of the syncline. The deposits are stratified and are conformable with the beds above and below. They have the same dip and strike as the associated rocks and are found dipping at angles varying from nearly vertical to nearly horizontal.

The ore of the Baraboo range is of lower grade than the average ore of the other Lake Superior ranges, generally containing less than 55 per cent of iron. It is soft hydrated hematite, in many places containing so much water as to be limonitic in character.

The iron ores of the Lake Superior district in general consist of high grade hematite, ranging from hard, dense, blue, specular, nonhydrated ore to soft, blue, red, or brown hydrated varieties. The upper portions of the deposits in general are more hydrated than the lower portions and in places contain sufficient water to form a brown ore. The ores are uniformly high in iron and low in phosphorus, so that the great bulk is of Bessemer grade. The soft ores, especially those of the Mesabi range, are frequently troublesome during smelting operations, but when they are mixed with hard ore this trouble is remedied.

The following tables show the average composition of the iron ores which are now mined and shipped in the Lake Superior district:

Average analysis of iron ore mined in the Lake Superior district during 1905.

Fe	59.6	P	.067
SiO_2	7.5	S	.019

Range in composition of iron ore mined in the Lake Superior district during 1906 and 1907.

	1906.	1907.
Fe	38.00–65.00	39.00–67.00
SiO_2	2.00–40.00	1.00–43.00
P	.008–.85	.01–1.00
S	.006–.13	.005–.14
Mn	.04–7.4	.03–8.7

Specular hematite in porphyry in the Ozark region.—The specular hematite in porphyry is confined to the pre-Cambrian areas of igneous rocks in southeastern Missouri. They were at one time very important, but are now practically exhausted. Ore has been found in large quantities at only two localities, viz, at Iron Mountain, St. Francois County, and Pilot Knob, Iron County. Shepherd and Cedar mountains, near Pilot Knob, have furnished small quantities of ore. At Iron, Shepherd, and Cedar mountains the iron ore occurs as veins in the porphyry; at Pilot Knob it occurs as a bedded deposit.

The granite and porphyry throughout the igneous areas contain numerous flakes and small veins of crystalline hematite, but only in the areas mentioned have deposits been developed. The porphyry is in places quite massive; elsewhere it has a distinct bedded structure.

The hematite vein deposits at Iron Mountain traverse the porphyry irregularly, having no definite strike or dip. They vary in thickness up to 60 feet or more in the decomposed porphyry at the surface, but narrow down to a few inches when the solid porphyry underneath is reached. In many places single veins divide into branches. In the solid porphyry the veins frequently form a perfect network with intervening rock fragments.

As the porphyry is weathered away, the iron-ore veins break up into blocks and form bowlder deposits in porphyry detritus on the surface of the porphyry. Locally detrital deposits occur at the contact of the porphyry and the overlying Cambrian sandstone, showing that the ores had been formed and were being eroded before the deposition of the Cambrian sediments.

At Pilot Knob the main ore body is in a bed interlayered with a slate and conglomerate formation which lies on the massive porphyry and is overlain by Cambro-Ordovician limestone. Veins like those at Iron Mountain also occur in the porphyry, but are of no importance. Bowlder deposits derived from the main bed occur at the surface in detrital material.

The bedded series between the porphyry and Cambro-Ordovician limestone has a position similar to the bowlder ore bed at Iron Mountain. It contains ore in two forms—(1) a solid bed of slaty ore 20 to 30 feet in thickness overlain and underlain by (2) conglomerate beds in which hematite occurs as interstitial material between pebbles and bowlders of sericitic and talcose material. The conglomerate beds are separated from the ore bed both above and below by thin layers of slate or slate and ore interlayered. The lower conglomerate has about the same thickness as the ore bed and rests directly on the solid porphyry. The upper conglomerate has an average thickness of about 100 feet and is overlain by the Cambro-Ordovician limestone.

The ore in the veins in porphyry at Iron, Shepherd, and Cedar mountains is compact and crystalline and of high grade; that in the

bedded deposit at Pilot Knob is slaty and consists of alternating layers of rich and poor ore. The following table shows the range in composition of the two types of ore:

Range in composition of iron ores from Iron Mountain and Pilot Knob.

	Iron Mountain.	Pilot Knob.
Fe	59.00 –68.00	44.00 –60.00
SiO_2	3.00 –11.00	4.00 –30.00
P	.005– .39	.005– .045

Specular hematite in sandstone in the Ozark region.—The specular sandstone hematite deposits occur in a circular area in the center of the Ozark uplift in Missouri, chiefly in Crawford, Phelps, and Dent counties, and subordinately in Franklin, Pulaski, Texas, and Shannon counties.

This area is surrounded by a zone in which the Ozark limonite deposits occur. In the latter zone southeast of the main Ozark uplift are the specular porphyry hematites described above.

The sandstone hematite deposits occur in the Roubidoux sandstone, of Cambro-Ordovician age, which usually forms a horizontal capping over the broader hills in the iron-ore area. The ores occur in lenses of circular or elliptical outline 300 to 500 feet in diameter and about one-fifth or one-sixth of the diameter in thickness. As a rule, they are horizontal, but occasionally they dip with the slope of the hills. The sandstone beds are in general horizontal, but in the vicinity of the ore bodies they are bent and broken and usually dip toward the deposit.

The ore deposits are surrounded and underlain by strata of gray or green chert, formerly continuous but now broken and disconnected, and in some places mixed with fine siliceous white clay or with red loam. Under the chert beds there are alternating strata of chert and sandstone, mostly broken up but locally continuous, and under these are the solid sandstone strata forming a circular depression in which the ore body lies. Above the deposits there is often a layer of sandy and cherty soil with fragmental material impregnated with iron ore.

The deposits may consist of bowlders of iron ore mixed with residual clay and fragments of chert and sandstone, or they may be in the form of compact, distinctly bedded masses.

The unaltered ore is hard blue or gray specular hematite which at the surface is altered to soft red hematite and limonite. The ore is fine grained and frequently very siliceous.

The iron content ranges from about 51 to 65 per cent and the phosphorus ranges from 0.022 to 0.12 per cent, thus constituting a fairly high-grade ore.

Clinton hematite.—Deposits of Clinton hematite occur in eastern Wisconsin and in Missouri. Those of Wisconsin are of considerable importance and have been mined for many years. Those of Missouri, according to H. A. Buehler, have only been discovered recently by drilling and occur at such depths as not to be at present workable.

In Wisconsin, the principal Clinton ores occur near Iron Ridge and Mayville, in eastern Dodge County, outcropping for several miles in a north and south direction. The entire Clinton formation is repre-

sented by iron ore which occurs in the form of a lens-shaped bed at the base of the Niagaran limestone and overlying the Cincinnatian shale. Small deposits of no commercial importance occur at the same horizon near Hartford, Washington County; near De Pere, Brown County; and west of Sturgeon Bay, Door County.

The bed in Dodge County varies in thickness from 15 to 25 feet and is nearly horizontal, the overlying Niagaran limestone forming a westward facing escarpment above it. The ore bed is made up of numerous horizontal layers 3 to 14 inches in thickness.

The ore consists chiefly of small lenticular concretions. The prevailing color is dark reddish-brown, though locally it becomes purple. It is generally soft and friable, containing just enough cement to keep the concretions together. The top layer varying from 3 to 8 inches in thickness differs from the rest in being hard and compact and of a deep purple color with bright scarlet streaks. It contains very few oolites and breaks with conchoidal fracture. Clay is intermingled with ore in the lower layers.

The ore is of about the same grade as the soft Clinton ores of the eastern district. It is smelted chiefly in local furnaces, though occasionally shipments are made to Milwaukee.

Carboniferous red hematite.—Bedded deposits of red hematite in the form of lenses and layers occur in the Carboniferous formations along the northern and northwestern border of the Ozark region. The ore beds are interlayered with sandstone and limestone, the most important deposits lying on limestone of lower Carboniferous age. They vary greatly in thickness, though locally they are quite persistent over considerable areas. The greatest thickness reported is about 7 or 8 feet of workable ore. The ore beds generally consist of a matrix of soft crumbly red ore in which there are lenses or kidneys of hard red ore. These lenses vary in size up to 2 feet in diameter and 10 inches in thickness. The deposits are practically undeveloped, and little is known as to their extent.

BROWN ORE.

Brown ores of the Claiborne formation.—Brown iron ores occur in the Claiborne formation of 20 counties in northeastern Texas and of 3 parishes in northwestern Louisiana. Occurrences are reported in southwestern Arkansas, but these are of no importance.

The following counties are known to contain deposits of iron ore in Texas: Cass, Morris, Marion, Upshur, Wood, Harrison, Gregg, Panola, Smith, Van Zandt, Rusk, Cherokee, Henderson, Anderson, Houston, Nacogdoches, Shelby, Sabine, San Augustine, and Camp; and the following parishes in Louisiana: Bossier, Claiborne, and Lincoln.

The Tertiary rocks of the district are divided into four formations with the following succession:

Succession of Tertiary rocks in northeastern Texas and northwestern Louisiana iron-ore district.

Lafayette formation (sand and gravels).
Claiborne formation (sands and greensands).
Sabine formation (clays and sands).
Midway formation (clays and limestones).

Only the second and third are of importance in connection with the iron-ore deposits.

The ores have been divided into three classes: (1) Brown laminated ores; (2) nodular or geode ores; and (3) conglomerate ores.

The following description of the ores is given by Dumble:[a]

The ore is a brown hematite of a rich chestnut color, and often of a highly resinous luster. In structure it varies from a compact massive variety showing no structure to a highly laminated form, the laminæ varying from one-sixteenth of an inch to one-quarter of an inch thick, frequently separated by hollow spaces, and sometimes containing thin seams of gray clay. These often give it a buff color and a crumbly nature, and hence the name often applied to it of "buff crumbly ore." The laminæ frequently show a black glossy surface, though the interior always is the characteristic rich chestnut-brown color.

The ore occurs in a horizontal bed from 1 to 3 feet thick, and averages between 18 inches and 2 feet in thickness. It is flat on top, but is bulging and mammillary below, and lies at or near the summits of the highest hills in the region. In fact, it is to this protecting cap of hard material that the hills owe their existence, as it has saved the underlying soft strata from the effects of erosion, which otherwise would quickly have lowered them to the level of the surrounding rolling country. The iron ore is directly underlain by a deposit, varying from 30 to 40 feet thick, of a soft yellow indurated glauconite (greensand). This bed is sometimes hardened into a soft rock easily cut with a saw or axe and locally used as a building stone. The interior of the bed, however, where it has not been exposed to the atmosphere, retains the dark-green color of the unaltered greensand. It contains considerable iron pyrites and numerous casts of fossils of the Claiborne epoch. This bed in turn is underlain by a great series of sands and clays, constituting the Timber Belt Beds (Sabine). Sometimes thin seams of iron ore are found in the greensand below the main ore bed, but they are small and rarely of value. At times they lie horizontally and at others occupy joint cracks. The main ore bed is usually directly overlaid by a thin seam of dark-brown and very hard siliceous sandstone, varying from 1 to 6 inches thick and averaging about 1½ inches. It adheres closely to the iron-ore bed, though the line of separation is sharp and well defined. Above this is a gray sandy deposit, becoming more clayey and ferruginous toward its base, and varying from 1 to 60 feet thick. This latter thickness is, however, very extreme, and the average is about 6 to 8 feet. As a rule the thickness of the ore depends, in a general way, on the thickness of the overlying sand bed, it being thicker where the sand is less than 15 or 20 feet than where it is greater. * * * The hills on which the ore occurs are steep and show a broad flat plateau-like surface, heavily capped with post oak, blackjack, and hickory, generally of a small size, but very dense. The ore crops out on the brinks of these hills, forming a protruding rim or crown and often covering the slopes with great masses which have broken off from the main bed. They are often deeply cut by the ravines of creeks which have originated in springs in the superficial sand and which flow away from the plateau in all directions, cutting deep gullies and exposing the ore bed along their courses.

The nodular or geode ores, though somewhat similar in chemical composition, are distinctly different in physical character and in their mode of occurrence from those already described. They are well developed in the northern part of Marion County and in southern Cass County, and extend thence into Morris, Camp, Upshur, and the counties lying to the west.

The ore is a brown hematite, and occurs in a great variety of forms. It very rarely shows the laminated structure of the brown laminated ores or their resinous luster. It generally occurs as nodules or geodes, or as honeycombed botryoidal, stalactitic, and mammillary masses. It is rusty brown, dull red, yellow, or even black in color, and has a glossy, dull, or earthy luster. The most characteristic feature of the ore is the nodular or geode form in which it occurs. Some of the beds are made up of these masses, either loose in a sandy clay matrix or solidified in a bed by ferruginous cement. The ores lie horizontally at or near the tops of the hills in the same manner as the brown laminated ores to the south of the Sabine River. The beds vary in thickness from less than 1 foot to over 10 feet, the thicker ones being interbedded with thin seams of sand. The ore-bearing beds are immediately overlain by sandy or sandy clayey strata. The sand beds are in the majority, though pure clay is found at some distance below the ore. The overlying sand beds are at times entirely eroded and the solid floor of brown hematite is exposed to view. In other places it is covered by

[a] Dumble, E. T., A general description of the iron ore district of east Texas: Ann. Rept. Texas Geol. Survey No. 2, 1890, pp. 28–31.

from 1 to 30 feet or more of sand. This overlying stratum varies considerably in character; sometimes the sands are loose and gray, at others more or less solidified and deeply stained by iron. Sometimes they contain considerable clay and show ferruginous segregations, so that a section of the bed discloses lumps of hard yellow semi-hardened sandy clay. The beds also often have a mottled red, yellow, and white appearance and contain thin seams of clay and lumps. The sands are very much cross-bedded, and frequently layers of hardpan or thin ore are seen following the lines of cross-bedding. Unlike the ores of Cherokee County, these beds are not dependent on the thickness of the immediately overlying sands.

Sometimes, though not so often as in Cherokee County, the ore is capped by a stratum of hard ferruginous[a] sandstone varying from 1 inch to over 1 foot in thickness, and occasionally similar beds are interstratified with the ore. The line of separation of the top sandstone and the ore bed is sharp and well defined. Though the iron is usually found near the tops of the hills, one or more beds are often seen at a lower level, lying horizontally like the upper bed and separated from it by sands. These lower beds, unlike those in Cherokee County, are often just as thick or thicker than the top beds. Such a formation as this, with its interstratification of soft and hard beds, gives a very characteristic topography to the country. As in the Cherokee region, the horizontal strata have been cut through by the numerous rivers and creeks, leaving flat-topped hills and plateaus, with steep escarpments and an alternately receding and protruding outline.

The conglomerate ores consist of a conglomerate of brown ferruginous pebbles one-quarter to 2 inches in diameter and cemented in a sandy matrix. Sometimes a few siliceous pebbles are also found. The beds vary from 1 to 20 feet thick, and are generally local deposits along the banks and bluffs, and sometimes in the beds of almost all the creeks and streams in the iron-ore regions just described. Sometimes they cap the lower hills. They are generally of low grade, but could be concentrated by crushing and washing out the sandy matrix. They usually contain more or less ferruginous sandstone in lenticular deposits, and are much cross-bedded. These ores are seen throughout east Texas from the Red River to the Brazos, but have as yet been put to no practical use, on account of the abundance of the other ores.

Brown ore of the Ozark region.—Brown-ore deposits occur in the Ozark region in Missouri and northern Arkansas in a zone surrounding the central Ozark plateau. The principal ore-bearing areas occur in the western, southern, and southeastern parts of this zone. Nearly 500 brown-ore localities are reported in Missouri, but of these less than 10 are at present being mined.

The brown ores occur in the limestone areas, where they are found in residual clay which covers the irregular surface of the limestone. The most numerous and extensive deposits lie on Cambrian limestone, while minor deposits occur over later limestones. In a few places ores are associated with clays where the bed rock is not apparent, while elsewhere most of the clay has been removed and the ores lie in masses and fragments on the exposed surface of the limestone. The ore is in the form of large and small fragments scattered through the clay or gathered into local pockets. The fragments vary in texture; some are stalactitic and others are amorphous and earthy. Chert fragments are associated with the ore and frequently are cemented together by limonite into solid masses of breccia. The ore is in every way similar to the Appalachian brown ores of the mountain and valley types.

Bog ore.—Bog iron ores are found in small deposits throughout the Mississippi Valley, but only at a few localities have they been mined, the most important of which are in Wisconsin. They are usually in the form of superficial blanket deposits mixed with more or less clay and earthy matter. Bog deposits are for the most part too small and isolated to pay for the expense of mining and trans-

[a] Frequently this sandstone is found alone and without any ore. In such cases it sometimes reaches a thickness of over 20 feet.

portation. Occasionally, however, deposits of such size are found as to permit the erection of a local furnace. Such deposits occur at Spring Valley and vicinity, Pierce County, Wis.

Limonite gossan.—Limonite gossan ore occurs in the upper part of the lead and zinc deposits in the upper Mississippi Valley. It results from the alteration of the iron sulphides, pyrite, and marcasite, which are associated with lead and zinc sulphides in the deeper parts of the veins. The gossan deposits of the Mississippi Valley are too small to be of commercial importance.

MAGNETITE.

Lake Superior magnetite.—Magnetite deposits worthy of notice are found in the Marquette, Mesabi, and Gunflint ranges of the Lake Superior district. They are related to the Lake Superior hematite deposits, being formed from the cherty iron carbonate or from the hematite deposits by igneous intrusives or by regional metamorphism. In the Marquette range magnetite is formed by both of these processes; in the other ranges it is formed by contact metamorphism by the great gabbro mass of northern Minnesota. This gabbro extends across the eastern part of the Mesabi range and has altered the iron formation along the contact to amphibole-magnetite rock and local magnetite deposits. Although considerable exploration has been done in this area, deposits of great importance have not been found.

In the Gunflint district in northern Minnesota near the Canadian boundary, the upper Huronian iron formations reappear from underneath the gabbro and extend northeastward into the Animikie district, Ontario. Near the gabbro contact the iron formation is altered to a coarsely crystalline green quartzite, with beds and lenses of magnetite associated with various ferrous silicates. The iron formation rests in Keewatin greenstone and dips away from it at steep angles. The magnetite lenses are most abundant near the contact with the greenstone.

Local occurrences of magnetite are also found at both ends of the Penokee-Gogebic range where the gabbro has come into contact with the iron formations.

Titaniferous magnetite.—Titaniferous magnetite in large bodies is reported to occur locally in the great gabbro mass of northern Minnesota. The most important of these deposits are located a short distance south of the Gunflint district. Little has been done with them in the way of exploration and they are practically unknown.

IRON CARBONATE.

Iron carbonate.—Iron carbonate and silicate originally composed the Lake Superior iron formation and are still found in scattered masses where they have been protected from weathering processes. They are described in connection with the Lake Superior hematite.

IRON SULPHIDE.

Iron sulphides.—Pyrite and marcasite occur in considerable masses in association with the lead and zinc ores. They give rise upon oxidation to limonite gossan deposits. They are utilized in the manufacture of sulphuric acid.

WESTERN DISTRICT.[a]

The iron ores of the western district may be divided into the following classes:

Hematite:
- Hematite in the pre-Cambrian schists of the Hartville district, in the Seminole Mountains, and near Rawlins, Wyo.
- Hematite associated with contact deposits of magnetite in many places in the West.
- Miscellaneous hematite deposits.

Brown ore:
- Limonite gossan ore forming a capping of metalliferous veins in many localities.
- Bog ore in Colorado, Montana, California, and Washington.
- Miscellaneous brown ore deposits.

Magnetite:
- Contact magnetite occurring in many places in the West, especially in west-central Colorado, southwestern New Mexico, southwestern Utah, southern California, and Shasta County, Cal.
- Titaniferous magnetite in southeastern Wyoming, in Colorado, and in Tehama and Los Angeles counties, Cal.
- Chromiferous magnetite of the Clealum region, Wash.
- Miscellaneous magnetite deposits.

Iron carbonate:
- Iron carbonate nodules found locally in the Laramie formation.

Iron sulphides:
- Iron sulphides associated with metalliferous ores.

HEMATITE.

Hematite in the pre-Cambrian schists.—Hematite deposits of considerable importance occur in the pre-Cambrian schists at several localities in Wyoming, viz: In the Hartville district, Laramie County, and near Rawlins, and in the Seminole Mountains, Carbon County.

The principal deposits are in the form of lenses occurring at the contact of schist and limestone. The ores are largely replacements in the schist and lie on a foot wall of limestone. The lenses have a strike and dip parallel to that of the rocks in which they occur. They range in length up to 1,000 feet and in width from a few feet to 100 feet or more. One ore body in the Hartville district is reported to have been tested to a depth of 900 feet. The following description of the distribution and character of these ores in the Hartville district is given by Ball:[b]

> The most important iron-ore deposits of the Hartville iron range are lenses that occur in schist on a limestone foot wall. The ore largely replaces the schist, although it partially fills cavities in the schist which are due to jointing, faulting, and brecciation. Detrital ores of secondary derivation from these deposits are situated (1) at the base of the Guernsey formation, (2) at the base of the Hartville formation, and (3) in the Tertiary lake and Pleistocene and Recent stream deposits. The pre-Cambrian jaspers, amphibolitized phase of the schist, and the matrix of some of the conglomeratic facies of the second pre-Cambrian series also locally contain considerable iron.
>
> The most important ore deposits next to the lenses above the contact of the pre-Cambrian schist and limestone are situated along the fault * * * north of Guernsey, between the pre-Cambrian series and the Guernsey formation * * *.
>
> The chief ore of these deposits [lenses in schist] is hydrated hematite. It is either (1) a hard gray ore filled with numerous cavities, which are lined with finely crystalline specular hematite, or (2) a soft greasy ore of brownish-red color. Fibrous varieties of hematite, including mammillary ore, grape ore, and stalactic ore, occur less frequently. Minor quantities of siderite and limonite are associated with the hematite. The limonite is in some places compact and finely granular; at others it is mammillary;

[a] Many of the descriptions of the western deposits were obtained from notes furnished by Messrs. R. C Hills and O. H. Hershey, mining engineers.

[b] Ball S. H. The Hartville iron range, Wyoming: Bull. U. S. Geol. Survey No. 315, 1907, pp. 190–205.

and at still others it is a soft yellow ocher. Magnetite is not present in masses large enough to attract the eye, although slight local magnetic variations noted at some places in the vicinity of the ore deposits may indicate its presence. Pyrite and marcasite were not observed and probably do not occur in the ore bodies.

The gangue minerals are calcite, quartz, gypsum, chalcedony, barite, and a kaolin-like mineral, and the copper minerals are chrysocolla, malachite, chalcocite, azurite, and native copper. Calcite occurs in colorless or slightly yellow crystals. The most important development of quartz, like that of calcite, is clearly later than the ore. It also occurs as brecciated fragments in the ore and is then older than the hematite, while to a less extent it is contemporaneous with the ore. At the Chicago mine the quartz sometimes is of a beautiful amethystine tint. The copper minerals occur in fractures in the hematite and associated rocks and are the younger.

Irregular masses of iron-stained schist, "soapstone," and to a less extent iron-stained limestone and iron-stained siliceous rocks occur as vein material in the ore bodies. Schist and soapstone occur as irregular horses throughout the ore body. The soapstone is an unctuous substance of pale green color.

The hard and soft ores grade into schist, and it is evident that each was formed through the replacement of the schist by hematite. The soft ore is thus in part derived directly from the schist, but a considerable portion of it is derived secondarily from the hard ore. Pseudomorphous replacements of hard ore by soft ore are common. Perhaps the best evidence of this change is seen in the pebbles of soft ore of beautifully rounded form that occur in the detrital deposits at the base of the Guernsey formation. Pebbles of this formation are usually of the dense, hard gray ore, and it is absolutely impossible that a substance offering as little resistance to attrition as the soft ore could form such well-rounded pebbles. The secondary character of much of the soft ore is further indicated by the fact that on the surface of the Sunrise mine the soft ore equals the hard ore in bulk, while on the lowest levels hard ore greatly predominates. In the Lone Jack tunnel, which after entering the hill gains considerable depth beneath the surface, the soft ore gradually decreases in amount from the entry of the tunnel to the breast, and at the latter point is practically absent. Alteration of the hard ore into the soft ore by percolating waters is well exemplified by the presence of soft ore along channels of maximum water circulation. There is also reason to believe that soft ore originates from the hard through shearing, since it occurs along many fault planes in the ore bodies.

The mammillary, grape, and stalactitic forms of hematite are clearly younger than the hard ore and in most places are younger than the soft ore. The mammillary ore occurs in fractures cutting the hard and soft hematite, while the grape and stalactitic ores cover cavities in the older varieties. Some of the mammillary ore was undoubtedly formed after the deposition of the detrital ore at the base of the Guernsey (Carboniferous) formation.

Limonite is a product of the surface alteration of the other iron-ore minerals. It occurs as pseudomorphs after both hematite and siderite. Great rounded bodies of limonite associated with an iron-stained flint are found in the Lone Jack and Sunrise open pits immediately beneath the Carboniferous rocks. The limonite and flint grade, on the one hand, into schist, and on the other into hematite, and are evidently a product of the surface alteration of the schist. Siderite occurs in cavities in the hematite and is clearly younger than it. After the deposition of the siderite came that of quartz in small crystals. Quartz is in turn at places coated with calcite. Of earlier origin than either the quartz or the calcite are the copper ores. These copper ores were, in the main, deposited after the Guernsey formation had been laid down, and in consequence the quartz and calcite were evidently formed in Carboniferous or post-Carboniferous times.

The ore of the Hartville iron range is a high-grade hematite, some masses of which contain over 68 per cent of iron, although the ore as a whole will probably not average over 60 per cent. * * * At the present time much of the ore shipped is of non-Bessemer grade. * * * Some of the ore is high in silica, its only other detrimental constituent [besides phosphorus].

Hematite associated with magnetite in contact deposits.—Hematite occurs mixed with magnetite in many of the western contact deposits. It is frequently so abundant as to constitute a magnetohematite. There are also many other magnetite deposits in the West of unknown origin which contain an abundance of hematite. Most of these miscellaneous deposits will also probably be found to be contact deposits.

Miscellaneous hematite deposits.—Hematite occurs in small scattered deposits of various forms, such as veins, breccia deposits, and replacements in many of the Western States. These deposits have not been sufficiently studied to be definitely classified. The following are some of the principal localities:

In the Cebolla district, Gunnison County, Colo., hematite and magnetite occur in limestone as layers and veinlike bodies conforming to the bedding of the inclosing rock. The deposits vary up to 10 feet in thickness. Associated with the hematite and magnetite are iron carbonate and limonite, which grade directly into limestone, the limonite being an alteration product of the iron carbonate. Locally considerable manganese ore is associated with the iron ores.

Small veins of hematite occur in granite north of Cotopaxi, Fremont County, Colo. The largest of the veins has a maximum width of 3½ feet and a length of 80 feet.

Similar deposits of hematite occur in granite a few miles northwest of Livermore, Larimer County, Colo. They are small and unimportant.

A deposit of specular hematite a few feet in thickness occurs on the Atlantic Cable claim near Rico, Dolores County, Colo.

A body of hematite the size of which is not known occurs in crystalline schist in Cochetopa Creek south of Parlin, Gunnison County, Colo.

Near Elizabethtown, Colfax County, N. Mex., there is a vein of specular hematite 5 to 7 feet in thickness. Other hematite deposits are found in New Mexico in the Capitan Mountains and in the Jarilla Mountains, but they are of no importance.

A deposit of hematite of brecciated character occurs in Rhodes Plateau, in the western part of the Uinta Mountains, Utah. The ore is in lower Carboniferous limestone, which it replaces along lines of fracture and brecciation. Unimportant bodies of hematite are reported from Cave Creek, north of the Mineral Range, Beaver County, and from Bear Valley, in the western part of Iron County.

An important body of hematite in pre-Cambrian metamorphic rocks occurs at Planet, Yuma County, Ariz., but the relations of the ore are not known to the writer.

South of Seligman, Yavapai County, Ariz., there is a large deposit of high-grade hematite in limestone. The outcrop is reported to be 600 to 700 feet long and 10 to 20 feet wide.

Small unimportant deposits of hematite are scattered through the Sierra Nevada and Coast Range in California. Such ores have been reported from Meadow Valley, Plumas County; from the southwestern part of Nevada County; from Ione and Clinton, Amador County; from the western part of Sonoma County; and from San Diego County.

Several deposits of hematite are found about 14 miles west of Valley, Stevens County, Wash. They are associated with limestones, slates, and schistose rocks.

BROWN ORE.

Limonite gossan ore.—A gossan of limonite occurs in many localities in the West as a capping of metalliferous sulphide deposits. Probably the most important localities where these occur are the Black

Hills, S. Dak.; Neihart and Monarch, Cascade County, Castle, Meagher County, and Elkhorn, Jefferson County, Mont.; Leadville, Lake County, Colo.; Tintic district, Juab and Utah counties, Utah; Tombstone, Cochise County, Ariz.; and Pioche, Lincoln County, and Eureka, Eureka County, Nev.; but many other deposits are known.

In most of the districts these ores contain an admixture of more or less manganese oxide. Some of the Leadville ores are so rich in manganese that they are used in the manufacture of spiegeleisen. For the most part, however, these ores are used as flux in copper and silver smelters in the districts in which they occur.

Bog ore.—Bog iron ores are found in scattered deposits in many localities in the Western States, and were among the first iron ores mined in this region. The following are the principal known deposits: Wickes, Jefferson County, Mont.; Titania Placer and Geneva Gulch, near Webster, Park County, Del Norte, Rio Grande County, Ophir, San Miguel County, Marshall Pass, Saguache County, Williams Creek, Huerfano County, and Crested Butte, Gunnison County, Colo. Small deposits occur elsewhere in many of the Western States.

Bog ores are usually in the form of surface deposits varying up to 10 or 15 feet in thickness but having a large horizontal extent, locally covering many acres. The ores are soft and porous and usually of low grade. In some places, as at Wickes, Mont., they contain a large percentage of bog manganese.

Miscellaneous brown-ore deposits.—There are many small deposits of brown ore throughout the Western States which have not been studied in sufficient detail to be definitely classified. Many of them belong to the preceding classes; others are replacements or concentration deposits.

The following are some of the best known localities:

In Colorado small bodies of limonite occur in Gibson Hill and Nigger Hill, near Breckenridge, in Summit County. A small deposit of hard limonite is found on the hillside back of the Hotel Colorado, at Glenwood Springs, in Garfield County. Several deposits of brown ore occur about 6 miles west of Villa Grove, toward Bonanza, in Saguache County. A deposit at Orient, Saguache County, has been worked for many years and is now nearly exhausted. The ore is limonite, which has resulted from the oxidation of bodies of pyrite, and it is expected that more and more pyrite will appear with depth. The Bennett ore body, which is about 3 miles south of the Orient mine, contains similar ore in the upper portion. Below water level, however, it consists of nearly pure pyrite.

In New Mexico a body of soft limonite 2 to 4 feet in thickness occurs about 8 miles northeast of Glorieta, in San Miguel County. The ore has been mined and used for flux in lead smelters.

In Utah, about 20 miles north of Vernal, near the Utah-Wyoming boundary, in Uinta County, there is a body of manganiferous limonitic iron ore 3 to 8 feet in thickness traceable for several hundred feet along the crest of a hogback. The country rock is sandstone of probable Mesozoic age. Deposits of limonite occur at Willard, Willard Canyon, and North Ogden Canyon, north and northeast of Ogden, and in Cottonwood Canyon, southwest of Ogden, in Weber County. Limonite occurs along Grouse Creek, in the extreme western part of Boxelder County, and the deposits extend over into Nevada.

Manganiferous brown ore is found in small quantities near Frisco, in Beaver County.

In Nevada brown-ore deposits are reported from Montello, Cobre, and Moor, Elko County, and from Winnemucca, Humboldt County.

In California brown-ore deposits occur at Campo Seco, Esmeralda, and Murphy, Calaveras County; at several localities in San Benito County; and near San Luis Obispo, San Luis Obispo County. The last-named deposit is in the form of a vein having an average width of about 10 feet and traceable for nearly a mile.

In Washington limonite ores are found near Trafton, Snohomish County; at Deep Lake, southeast of Northport; and also east of Valley, Stevens County. At the Stevens County localities the ore occurs chiefly as a replacement of limestone.

MAGNETITE.

Contact magnetite.—Contact magnetite deposits are the principal classes of iron-ore deposits in the West. They are widely scattered, but occur chiefly in Colorado, New Mexico, Utah, and California.

The following is a list of the principal deposits:

In Colorado they occur at Taylor Peak, Gunnison and Pitkin counties; at White Pine, Gunnison County; and at Calumet, Fremont County.

In New Mexico they occur at Fierro and Hanover, Grant County, and at Chupadera Mesa, Socorro County.

In Utah they occur at Iron Springs, Iron County, and at Bull Valley, Washington County.

In California they occur at Pitt River, Shasta County; at Newton, Nevada County; at Hotaling, Placer County; Eagle Mountains, Riverside County; and at Providence Mountains, Cave Canyon, Iron Mountain, and Iron King, San Bernardino County.

In addition, there are many other magnetite deposits in the West whose exact nature is not known because they have not been scientifically studied, although they are thought to be contact deposits. Many of these are mentioned under the head of "Miscellaneous magnetite deposits."

The contact magnetite deposits of the West are a distinct type, but approach very closely in structure the Cornwall magnetites of eastern Pennsylvania. Only the ores of the Iron Springs district, in Utah, have been studied in detail.

In general the deposits may be said to occur (1) as replacement deposits in limestone or other sediments at or near the contact of an intrusive igneous mass, or (2) in veins within the igneous masses. The igneous rock is generally of a dioritic, granitic, or andesitic character. The sedimentary rock associated with the ore deposits is characteristically limestone, though locally small deposits of ore are found in association with sandstone or shale. The latter are generally in the form of breccia deposits and veins rather than replacement deposits, which is due to the fact that clastic sediments are replaced only with great difficulty, whereas limestones are readily altered.

The deposits near the contact are in the form of lenses, the large diameter of which is parallel to the contact. They vary in length up

to 3,000 feet or more and in width up to 1,000 feet or more. A single deposit may contain 15,000,000 to 20,000,000 tons. They have not been tested to a depth greater than about 150 feet, but from the nature of the deposits they may be expected to extend downward along the contact for great distances. The dip of the ore bodies is roughly the same as the dip of the adjacent contact. The foot wall is generally the igneous mass, but in many places a layer of quartzite, sandstone, or shale intervenes. The hanging wall is limestone, frequently silicified for a considerable distance from the contact with the ore. The minerals associated with the ores are largely metamorphic types, such as garnet, pyroxene, epidote, amphibole, serpentine, apatite, feldspar, and mica. Calcite and quartz also occur abundantly.

The veins of ore in the igneous masses rarely have a greater width than 20 feet but may have a horizontal extent of 2,500 feet or more. As these deposits are usually small, they have not been developed, and their vertical extent is unknown.

Contact magnetite ores are supposed to have originated from a deep-seated source, to have come up through cracks in the igneous mass during its cooling, and to have penetrated the overlying sediments and replaced them. According to this theory, the ore veins in the igneous rock represent the fissures through which the ore-bearing solutions came to the surface, and the contact deposits represent replacements of the overlying sediments. If this theory be true, it may be expected that contact deposits pass downward into vein deposits and that the latter extend to great depths.

The ore is mostly dense compact magnetite, but in many localities hematite is abundantly intermixed with it. It is usually high in iron, but contains too much phosphorus for a Bessemer ore.

Titaniferous magnetite.—Titaniferous magnetite is known at six localities in the western United States, viz: At Iron Mountain, Laramie County, in Wyoming; at Caribou, Boulder County, Grape Creek, Fremont County, and Cebolla, Gunnison County, in Colorado; and at Tujunga and Pacoima canyons, Los Angeles County, and Beegum, Tehama County, in California. If methods for economical concentration of titaniferous ores are perfected the Iron Mountain occurrence will be of considerable commercial importance. The Cebolla and Beegum deposits also are reported to be of large size. The other occurrences are unimportant.

The ore occurs as dikelike masses, small veins, or irregular patches in basic igneous rocks of the gabbro-pyroxenite-peridotite series. They consist of magnetite and ilmenite with an admixture of silicate minerals common to the associated rocks.

Chromiferous magnetite in central Washington.—A series of deposits of chromiferous magnetite occur along the Wenatchee mountain range in the northern part of Kittitas County, central Washington. The principal rock along this range is a peridotite formation altered to serpentine. This was intruded into earlier sediments and volcanics and has itself been intruded by later and more acid rocks. It is overlain by Tertiary (Eocene) sediments, largely sandstone, and by basalt flows. The formation immediately overlying the serpentine is the Swauk sandstone, which was deposited on its eroded uneven surface. At their contact and within both are found the iron ores. These are in the form of lenses varying from a few feet to 30 feet in

thickness in the lower part of the sandstone and of irregular replacement deposits which extend downward from the lenses into the underlying serpentine.

The ore in the sandstone is oolitic in texture; that in the serpentine is dense and amorphous and breaks with a conchoidal fracture. The oolitic variety is the principal ore in most of the deposits, but in places it has been entirely eroded so that only the replacement ore remains.

The ore was apparently deposited locally as carbonate or hydrous oxide on the erosion surface of the serpentine, and later was covered with sediments. Subsequently, it was metamorphosed and dehydrated.

The ore is highly aluminous and contains up to 5 per cent and over of chromic oxide, but is by no means a chromic iron ore.

Miscellaneous magnetite deposits.—Magnetite deposits which probably belong largely to the class of contact deposits but whose nature is not known for lack of detailed study occur in Colorado, New Mexico, Nevada, Arizona, and California.

The following are the principal localities: In Colorado, a vein of magnetite 3 to 4 feet in thickness is exposed for several hundred feet on Tarryall Creek above Como, in Park County. In the Capitol and Snowmass mountains in the western part of the Elk Mountains in Pitkin and Gunnison counties, there are several deposits of magnetite, which, however, are practically inaccessible. Near Pitkin and Tincup in the eastern part of Gunnison County, there are several iron ore bodies which are probably similar to those on Taylor Peak and White Pine. In Mineral Basin at the head of Cottonwood Creek in the western part of Chaffee County, a small deposit of magnetite occurs at or near the timber line. Several small deposits are reported from Monarch in the southwestern part of Chaffee County. A deposit of magnetite and hematite occurs in Badger Creek, in the western part of Fremont County.

In New Mexico, magnetite deposits which may become of some importance occur near White Oaks and Ancho and at other localities in the Jicarilla Mountains, in Lincoln County. Minor deposits in New Mexico are reported also from the Zuni Mountains, Valencia County; from the San Mateo Mountains, Socorro County; and from the Tuerto Mountains, Santa Fe County.

In Arizona, siliceous low-grade magnetite bodies occur in the Black Mask group of claims in northern Yuma County, 30 miles northwest of Quartzite.

In Nevada, several important deposits of magnetite occur in the southern part of Humboldt County, some distance east of Lovelocks. They appear to be replacements of basic eruptive rocks resembling schists. More than 30 ore bodies occur, all of which are over 100 feet in length and 20 feet in width. The largest body is 400 feet in length and 250 feet in width. The ore is high-grade magnetite. In the Cortez Mountains in Eureka County, are the Amarillo iron ore deposits. They are low grade, but of considerable extent. Minor deposits occur near Bullion and in the Dolly Varden district, in Elko County.

In California, important bodies of magnetite, which are probably largely of the contact type, are found in Madera and San Bernardino counties. Minor deposits occur in the northern part of Butte County; in Gold Valley and vicinity, Sierra County; in Placer and Eldorado

counties; in southwestern Kern County; and in north central Los Angeles County. The Madera County deposits are said to be the largest iron ore deposits in the State, but they are at present almost inaccessible. They consist of two groups, the Minaret deposits and the Mount Raymond deposits. The Minaret deposits occur at the head of San Joaquin River in the southeastern part of Yosemite National Park, and the Mount Raymond deposits are on a peak of that name a short distance south of the park and 15 or 20 miles southwest of the Minaret deposits. The ores of the Madera County deposits are magnetite and specular hematite. The following magnetite deposits are reported from San Bernardino County, besides the known contact deposits mentioned above: Owl Holes, Kingston Range, and Garlic Spring in the northern part, and Iron Age and Newberry in the southern part. Little is known as to the extent and nature of these deposits, but most of them are probably contact ores of the same type as the other iron ores of southern California.

IRON CARBONATE.

Iron carbonate.—Kidneys and concretions of iron carbonate partially altered to limonite are found scattered over the surface of the ground in local areas in Colorado and northern New Mexico, where the Laramie formation is the surface rock. They are of no commercial importance.

IRON SULPHIDE.

Iron sulphides.—Pyrite and other iron sulphides are associated with metalliferous sulphides in most of the western precious-metal districts. They give rise to limonite gossan deposits.

IRON-ORE RESERVES OF THE UNITED STATES.

During the fall of 1908 estimates were made of the reserves of various mineral products of the United States by the National Conservation Commission. The estimates and the report on iron ores were prepared by Dr. C. W. Hayes, of the United States Geological Survey. Separate estimates were made of ore available at the present time and ore not now available for each of the different mining and commercial districts, and for the different varieties of ore.

On the following pages are given extracts from the report of Dr. Hayes.[a]

VALUE OF ESTIMATES.

It will be readily understood that with the great diversity in type of deposits there must be a very wide difference in the degree of accuracy with which the ore can be estimated. The closest approximation can be made in the case of bedded deposits such as the Clinton red hematites. These beds vary in thickness and composition from place to place, but the variations are similar to those characterizing other sedimentary beds, such as coal, and with a minimum amount of testing on the outcrop and at depth their contents can be calculated with a fair degree of certainty. Certain assumptions, however, must always be made. Thus it is assumed that observed variations in composition and thickness continue with regularity between and beyond points of observations; also that a certain depth will limit workability. This limiting depth will depend upon a variety of conditions which can not be determined in

[a] Hayes, C. W., Iron ores of the United States: Bull. U. S. Geol. Survey No. 394, 1909.

advance of mining, and hence the depth fixed upon in making calculations will be largely a matter of opinion, and must be expected to change with changing commercial conditions. Hence it is doubtful if even the best known and most thoroughly tested deposits of red hematite can be estimated within 10 per cent of their actual yield. At the other extreme are the concentration deposits of brown ore. These are extremely variable in both depth and horizontal extent. Surface indications are thoroughly unreliable, and those most experienced in working such deposits are practically unanimous in the opinion that no deposit can be safely estimated until every ton of ore has been mined. Under such circumstances the estimates given below of ore remaining in this class of deposits can only be regarded as having a degree of accuracy represented by a factor varying between 0.7 and 3.

Intermediate between these extremes are the most important deposits, including those of the Lake Superior and Adirondack districts. The former, by reason of their greater regularity and the thoroughness with which they have been tested, may be considered as known within 15 or 20 per cent. The latter are much less fully tested, and estimates of their probable yield are based upon assumptions which further development may prove to be erroneous. Estimates of the western ore deposits vary in value because of inherent uncertainties due to the nature of the deposits and to the very unequal information concerning different districts.

AVAILABILITY.

Any estimate of the iron-ore supplies of the United States must separate the ores into two classes on the basis of availability. This separation is difficult, and opinions vary widely as to where the line should be drawn. Evidently the question is one of costs: (a) The cost of the ore delivered at the furnace, and (b) the cost of reduction. Actual production, past and present, being determined by the interaction of various factors, affords the best criteria of availability.

The two factors which enter most directly into the cost of ore at the furnace are accessibility and mining conditions. Many iron-ore deposits are known in regions so remote from fuel supply and from transportation lines that they may be considered unavailable at present or so long as they are compelled to compete with more accessible ores. At the same time they must be taken into account in considering the total reserves, for accessibility is only relative, and no deposit, if sufficiently large to warrant the expenditure necessary for constructing roads, can be regarded as permanently inaccessible. Distance from fuel is, of course, a more serious drawback than absence of present means of transportation, while those supplied with water transportation will bear a longer haul than those carried entirely by rail.

Mining conditions may be such as to make the cost of raising the ore prohibitive at present. Such conditions are limiting depths beyond which mining, on account of the amount of water, may become very expensive, or thinness of the beds which necessitates a large amount of dead work. These conditions apply particularly to the Clinton ores and explain the difference between the total amount proved in these deposits and the amount considered at present available. Many deposits of brown ore can be worked cheaply in open pits for a certain distance from the surface, while the cost of stripping or of timbering to hold back the inclosing clay prevents their working to greater depths.

Another kind of limiting conditions arises from the fact that in many cases the ore is mixed with foreign material from which it must be separated. Thus many of the brown ores consist of small concretions scattered through clay, and a large amount of material must be passed through the washer to obtain the ore in suitable condition for the furnace. The ratio of ore to clay in deposits now being worked varies from 1:5 down to 1:20. When conditions permit the lowering of this ratio still further, large quantities of ore will be available in material which can not now be worked at a profit. Similar conditions control the availability of many of the magnetic deposits, except that here the objectionable elements are other minerals that are closely associated with the iron and must be separated by magnetic methods. The concentrated material is a high-grade ore, and the ratio of available to nonavailable in these deposits depends wholly upon cost of the process of concentration which they will bear in competition with other ores.

The second consideration affecting availability is the character of the ore itself. The content of metallic iron in ores used at present varies from 30 to 65 per cent. This wide variation is due in part to the nature of the other elements in the ore and in part to advantageous location. Thus the Clinton ores, containing as low as 30 per cent iron, can be used with advantage, because the lime which they contain makes them practically self-fluxing. At the same time they must be used near the point of production, since the low content of iron will not permit long transportation in

competition with richer ores. On the other hand, siliceous ores containing less than 40 per cent iron are not considered at present available unless their location near the fuel is exceptionally favorable, since the cost of transportation per unit of iron is excessive and since a large amount of fuel is required to remove the silica. But there are enormous quantities of siliceous ore carrying from 35 to 40 per cent iron, particularly in the Lake Superior district, and this must be taken into account as a future reserve, though not at present available.

In the case of the titaniferous magnetites the ratio between the available and not available is difficult to determine. While these ores have been used only to a limited extent because of the difficulties attending the fluxing of the titanium, it seems probable that these difficulties will be overcome and a much larger use made of them, either by employing a special flux in the furnace or by reducing the percentage of titanium in the charge by concentration or mixing with nontitaniferous ores.

The percentage of other constituents, such as phosphorus, sulphur, copper, chromium, manganese, and alumina, will determine the method and cost of reduction and the quality of the resulting iron. Hence these constituents, some of which are highly deleterious, may determine the question of availability by limiting the conditions under which the ore can be reduced or the product used.

Another factor is the nature of ownership. Where a large corporation controls a variety of ores and is equipped to assemble them and form any desired mixture or grade, ores may be used with advantage which would not be available if held by a smaller company not in a position to control the situation in a large way or compelled to dispose of a single kind of ore in the open market.

Because of the varying importance of these factors future availability will obviously vary in a corresponding degree, and the advantage which one district now possesses may pass to another. As the higher-grade ores of the Lake Superior region become depleted the lower-grade ores will be called on with consequent increase in cost of transportation and smelting. The low-grade ores of the southeastern district, at present competing with the high-grade Lake Superior ores, will then have a decided advantage because of proximity to fuel supply.

The notable present tendency in the iron industry is the lower average iron content in the ores used. This tendency will undoubtedly continue in the future as the more easily accessible portions of the richer deposits are worked out. As a corollary to this is the observed tendency toward a decentralization of the iron industry, and with a decrease in the iron content of the ore used, involving a corresponding increase in cost of transportation per unit of iron, there will be an increase in the proportion of fuel which goes to the region producing the ore. This will be accompanied by the general adoption of by-product coking. It is an instructive fact that in certain furnaces now operating in the Lake Superior district the profit corresponds approximately to the value of the by-products from the coke ovens.

In making estimates all of these considerations, together with the best forecast that can be made of conditions as they will exist in the next ten years, have been taken into account in determining the ratio between available and nonavailable supplies.

ESTIMATES OF IRON-ORE RESERVES.

In the following tables are given Doctor Hayes's estimates of the iron-ore tonnages of the principal mining districts by varieties, according to availability:

Estimates of Lake Superior ores.

District.	Available.	Not available.
	Long tons.	*Long tons.*
Michigan:		
Marquette district	110,000,000	15,900,000,000
Gogebic district	95,000,000	3,900,000,000
Menominee, Crystal Falls, and other districts	80,000,000	7,360,000,000
Minnesota:		
Mesabi district	3,100,000,000	39,000,000,000
Vermilion district	60,000,000	1,005,000,000
Cuyuna and other districts	15,000,000	310,000,000
Wisconsin	40,000,000	4,525,000,000
	3,500,000,000	72,000,000,000

Estimates of Adirondack ores.

	Available.	Not available.
	Long tons.	*Long tons.*
Nontitaniferous magnetites:		
High-grade ores	35,000,000	
Concentrating ores (concentrates)	75,000,000	25,000,000
Titaniferous magnetites	90,000,000	100,000,000
Red hematites	2,000,000	2,000,000

Estimates of Clinton ores.

District.	Available.	Not available.
	Long tons.	*Long tons.*
Birmingham	358,470,000	438,000,000
Chattanooga	86,570,000	440,000,000
New York	30,000,000	570,000,000
Virginia-North Tennessee	16,000,000	50,000,000
Wisconsin	10,000,000	30,000,000
Pennsylvania	5,000,000	50,000,000
Kentucky-West Virginia	2,500,000	42,500,000

Estimates of Appalachian metamorphic ores.

Ores.	Available.	Not available.
	Long tons.	*Long tons.*
Magnetites, including some titaniferous magnetites and some hematite	47,500,000	74,500,000
Specular hematites, including some limonites	8,000,000	53,000,000

Estimates of Appalachian brown ores.

	Available.	Not available.
	Long tons.	*Long tons.*
New England and New York	1,000,000	1,500,000
Pennsylvania, Maryland, and New Jersey	10,000,000	12,000,000
Virginia, West Virginia, and East Tennessee	35,150,000	136,000,000
Alabama, Georgia, and North Carolina	19,250,000	32,000,000

Estimates of Appalachian carbonate ores.

	Available.	Not available.
	Long tons.	*Long tons.*
Pennsylvania		46,000,000
Ohio		200,000,000
Kentucky		60,000,000
Tennessee-Alabama		2,000,000

Estimates of west Tennessee brown ores.

	Available.	Not available.
	Long tons.	*Long tons.*
Northwestern Alabama Western Tennessee Kentucky	10,000,000	15,000,000

Estimates of east Texas brown ores.

	Available.	Not available.
	Long tons.	*Long tons.*
Northeastern Texas	260,000,000	500,000,000

Estimates of Ozark ores.

	Available.	Not available.
	Long tons.	*Long tons.*
Sandstone hematite	15,000,000	5,000,000
Brown ore	30,000,000	45,000,000
Red hematite		5,000,000

Estimates of igneous contact ores.

	Available.	Not available.
	Long tons.	*Long tons.*
Cornwall district, Pennsylvania	15,000,000	35,000,000
Iron Springs district, Utah	40,000,000	80,000,000

In the following tables are given Doctor Hayes's summary of the estimates of domestic iron-ore reserves by commercial districts and varieties of ores, and his estimate of foreign supplies of ore sufficiently high in grade and accessible to mining and transportation to be at present available and so located as to affect the iron industry of the United States:

Estimates of iron-ore supplies of the United States.

Commercial districts (States).	Magnetite ores.			
	Nontitaniferous.		Titaniferous.	
	Available.	Not available.	Available.	Not available.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
1. Northeastern	160,000,000	111,500,000	90,000,000	100,000,000
2. Southeastern	[a] 12,500,000	23,000,000		
3. Lake Superior		4,500,000,000		25,000,000
4. Mississippi Valley				
5. Rocky Mountain	[a] 51,485,000	[a] 115,440,000		1,500,000
6. Pacific Slope	[a] 68,950,000	11,800,000		2,000,000
	292,935,000	4,761,740,000	90,000,000	128,500,000

Commercial districts (States).	Hematite ores.			
	Specular and red.		Clinton.	
	Available.	Not available.	Available.	Not available.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
1. Northeastern	2,000,000	2,000,000	35,000,000	620,000,000
2. Southeastern	8,000,000	53,000,000	463,540,000	970,500,000
3. Lake Superior	3,500,000,000	67,475,000,000	10,000,000	30,000,000
4. Mississippi Valley	15,000,000	10,000,000		
5. Rocky Mountain	4,275,000	2,100,000		
6. Pacific Slope		10,000,000		
	3,529,275,000	67,552,100,000	508,540,000	1,620,500,000

[a] Includes some hematite.

Estimates of iron-ore supplies of the United States—Continued.

Commercial districts (States).	Brown ores.		Carbonate ores.		Total supplies.	
	Available.	Not available.	Available.	Not available.	Available.	Not available.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
1. Northeastern	11,000,000	13,500,000	.....	248,000,000	298,000,000	1,095,000,000
2. Southeastern	54,400,000	168,000,000	.....	62,000,000	538,440,000	1,276,500,000
3. Lake Superior	.....	.....	.....	.....	3,510,000,000	72,030,000,000
4. Mississippi Valley	300,000,000	560,000,000	.....	.....	315,000,000	570,000,000
5. Rocky Mountain	2,000,000	1,625,000	.....	.....	57,760,000	120,665,000
6. Pacific Slope	.....	105,000	.....	.....	68,950,000	23,905,000
	367,400,000	743,230,000	.....	310,000,000	4,478,150,000	75,116,070,000

1. Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Ohio.
2. Virginia, West Virginia, eastern Kentucky, North Carolina, South Carolina, Georgia, Alabama, east Tennessee.
3. Michigan, Minnesota, Wisconsin.
4. Northwest Alabama, west Tennessee, west Kentucky, Iowa, Missouri, Arkansas, east Texas.
5. Montana, Idaho, Wyoming, Colorado, Utah, Nevada, New Mexico, west Texas, Arizona.
6. Washington, Oregon, California.

Estimated foreign iron ores.

	Long tons.
Canada:	
British Columbia, magnetite chiefly	30,000,000
Lake Superior district, hematite chiefly	9,000,000
Nova Scotia, Clinton hematite	4,000,000
Newfoundland, Clinton hematite	30,000,000
Cuba:	
Santiago district, hematite	5,000,000
Mayari, Moa, Baracoa, Cubitas, and Pinar del Rio districts (limonite)	1,500,000,000
	1,578,000,000

WASTE IN MINING AND REDUCTION.

Where iron ore occurs in the form of bedded deposits and is mined underground, waste is apt to occur from the same causes as in coal mining. These are the leaving of pillars to support the roof, often unnecessarily large, the leaving of low-grade ore in the mine where it can subsequently be recovered only with difficulty, if at all, and the breaking down of an overlying bed where the lower of two beds in the same territory is mined first. These sources of waste are confined largely to the Clinton ores, and the available facts are insufficient for closely estimating its amount, but the proportion of recovery varies with local conditions between 75 and 90 per cent, and is undoubtedly increasing with improvement in mining methods. In computing the available tonnage of the Clinton ores an average recovery of 75 per cent has been assumed. Portions of the Clinton ore beds at present considered of no value because of shale partings and consequently left in the ground might be mined at many points if the shale could be separated from the ore economically. Improvement in cleaning and concentrating methods will undoubtedly make the recovery of much ore of this character possible. In the steeply dipping magnetite and hematite beds practically all ore up to the required grade is mined out, and the ground is generally left in such condition that the mines can be reopened for the recovery of lower-grade ores.

In surface workings waste is confined largely to small operations where quick returns are required, and systematic development is impossible. In such cases much ore is lost by dumping barren strippings and low-grade ore together, so that it can be recovered only with difficulty, if at all. Where the operations are on a large enough scale to warrant the installation of mechanical excavators and a proper ore-dressing plant this waste does not occur, and practically all the ore in a deposit is recovered. Some waste of finely divided ore occurs in the process of washing brown ores to remove the associated clay, and there is still room for improvement in operations of this kind. If it becomes necessary to mine material which is below the grade of present requirements, but which contains enough iron values to make it a possible ore in the future, such material is stacked so that it will be available at any future time. This policy has been

most consistently followed in the Lake Superior district, and when such low-grade ores are required large amounts will be available merely at the cost of loading on the cars.

In the early days of iron making an appreciable part of the iron in the ores went into the slag and was permanently lost. Blast-furnace practice, however, has been so greatly improved in recent years that this source of waste is eliminated and practically all of the iron in the ore is now recovered.

DURATION OF THE IRON-ORE SUPPLY.

Predictions of the date of exhaustion of the iron-ore reserves involve a number of unknown factors, each of which adds to the uncertainty of the result. Among these factors the following may be mentioned:

1. The uncertainties of the estimates of reserves and the difficulty of fixing the ratio of the two classes have been fully explained in the sections devoted to the description of the ore deposits.

2. The extent to which imported ores will supplement the domestic supply can not be foretold, but it will be an increasingly important factor.

3. The extent to which the reserves will be increased by the discovery of new ore bodies can not be estimated, but it is highly improbable that all the important iron-ore deposits are now known.

4. The ores of the first class will not be entirely exhausted before utilization of the second class begins, and changing conditions, particularly of transportation and metallurgy, will continually shift the line dividing the two clsasses.

5. The stock of metal which can be reworked is constantly increasing and must eventually reduce the demand for metal obtained directly from the ores.

6. The substitution of other materials for metal now used for certain purposes, particularly for construction, will reduce the consumption to an extent which can not be even approximately estimated, and, on the other hand, the proportion of structures into which iron enters as an important constituent will undoubtedly increase.

7. The per capita consumption of iron ore has shown a rapid increase since the beginning of the iron industry. For 1907 and the four preceding census years it has been as follows: 1870, 180 pounds; 1880, 313 pounds; 1890, 560 pounds; and 1900, 806 pounds; and 1907, 1,344 pounds.

8. The increasing cost of iron, due to the increase in cost of fuel and the use of lower-grade ores requiring an increased amount of fuel per ton of iron smelted, will induce greater economy in the use of the metal, on the other hand, improvements in metallurgy will tend to secure a larger yield of metal for a given expenditure of fuel and power and may substitute low-grade fuel for the higher-grade coal now required in the blast furnace.

The most striking feature of the iron-ore production curve is the remarkable rate of increase shown in the period covered. Taking the production since 1870 by decades and estimating the last two years of the present decade, 1908 and 1909, the percentage rate of increase for each decade over the one preceding is shown in the following table:

Production of iron ore by decades and rate of increase.

Decade.	Quantity.	Percentage of increase.
	Long tons.	
1870–1879	43,770,527	.....
1880–1889	91,043,854	108.0
1890–1899	163,989,193	80.1
1900–1909	[a] 392,000,000	138.0

[a] Approximate.

Each of the above decades, as shown by the production curve, contains a depression in which there was an actual decrease in production, so that they may be taken as fairly representing the tendency of the industry. These rates of increase are such that they do not permit the construction of a curve on which prediction for the future can be based. A comparison of the first and second rates, 108 and 80.1, would indicate a rapid decrease in the rate of increase, which, if continued, would have placed the date of maximum production about 1930. But a comparison of the second and third rates,

80.1 and 138, would indicate a rapid increase in the rate of increase. If the average rate of increase by decades, 108.7 per cent, should be continued, it would require the production in the next three decades of 6,088,000,000 tons. But the ore supply now available in the United States is estimated at 4,788,000,000 tons, which is only 78 per cent of the amount needed on this assumption. It is evident, therefore, that the present average rate of increase in production of high-grade ores can not continue even for the next thirty years, and that before 1940 the production must already have reached a maximum and begun to decline, and a very large use must be made of low-grade ores not now classed as available. The second condition, with its consequently greatly increased cost of iron, is the only thing which can prevent a decline in the iron industry, measured by the amount of pig iron produced, within the next thirty years, unless there is in the meantime very greatly increased importation of foreign ores.

In view of the many factors entering into the problem, the tendency of which is not always determinable, to say nothing of the weight that should be given them, any further prediction as to the date of exhaustion of the iron-ore supplies is so uncertain as to be wholly unprofitable and unwarranted.

IRON AND STEEL INDUSTRY OF THE UNITED STATES.[a]

PRODUCTION OF PIG IRON BY STATES.

During 1908 the production of pig iron amounted to 15,936,018 long tons, as compared with 25,781,361 long tons in 1907 and 25,307,191 long tons in 1906. The 1908 production was less than that of any year since 1901.

In the following table the pig-iron production of the United States is given, by States, for 1906, 1907, and 1908:

Production of pig iron, 1906–1908, by States.

State.	Blast furnaces.				Production, including spiegeleisen and ferromanganese, in long tons.		
	In blast June 30, 1908.	December 31, 1908.			1906.	1907.	1908.
		In.	Out.	Total.			
Pennsylvania	61	87	73	160	11,247,869	11,348,549	6,987,191
Ohio	23	39	34	73	5,327,133	5,250,687	2,861,325
Illinois	14	14	11	25	2,156,866	2,457,768	1,691,944
Alabama	20	25	26	51	1,674,848	1,686,674	1,397,014
New York	8	15	12	27	1,552,659	1,659,752	1,019,495
Virginia	9	10	16	26	483,525	478,771	320,458
Tennessee	10	12	9	21	426,874	393,106	290,826
Colorado	2	3	3	6	413,040	468,486	313,071
Missouri	2	2	0	2			
Maryland	2	2	3	5	386,709	411,833	183,502
New Jersey	2	3	8	11	379,390	373,189	225,372
Wisconsin	2	4	3	7	373,323	322,083	148,938
Minnesota	0	1	0	1			
Michigan	5	8	6	14	369,456	436,507	348,096
West Virginia	1	1	3	4	304,534	291,066	65,551
Kentucky	2	2	6	8	98,127	127,946	45,096
Georgia	1	2	2	4	92,599	55,825	24,345
Texas	1	0	4	4			
Connecticut	2	2	1	3	20,239	19,119	13,794
Massachusetts	0	1	1	2			
Indiana	1	3	0	3	.....	(b)	(b)
	168	236	c223	c459	25,307,191	25,781,361	15,936,018

[a] The pig iron and steel statistics in the following pages were collected and published by James M. Swank, general manager of the American Iron and Steel Association, in his annual statistical reports.

[b] Tonnage included with Michigan.

[c] Including 1 idle stack each in Oregon and Washington.

PRODUCTION OF PIG IRON BY GRADES.

The following table shows the production of different grades of pig iron from 1904 to 1908:

Production of pig iron in the United States, 1904–1908, by grades, in long tons.

Grade.	1904.	1905.	1906.	1907.	1908.
Bessemer and low-phosphorus	9,098,659	12,407,116	13,840,518	13,231,620	7,216,976
Basic (mineral fuel)	2,483,104	4,105,179	5,018,674	5,375,219	4,010,144
Forge pig iron	550,836	727,817	597,420	683,167	457,164
Foundry and ferrosilicon	3,827,229	4,758,038	4,773,011	5,151,209	3,637,622
Malleable Bessemer	263,529	635,236	699,701	920,290	414,957
Spiegeleisen	162,370	227,797	244,980	283,430	111,376
Ferromanganese	57,076	62,186	55,520	55,918	40,642
White, mottled, direct castings, etc	54,230	69,011	77,367	80,508	47,137
	16,497,033	22,992,380	25,307,191	25,781,361	15,936,018

PRODUCTION OF PIG IRON ACCORDING TO FUEL USED.

In the following table is given the production of pig iron according to the fuel used from 1904 to 1908, inclusive:

Production of pig iron according to fuel used, 1904–1908, in long tons.

Fuel used.	1904.	1905.	1906.	1907.	1908.
Bituminous, chiefly coke	14,931,364	20,964,937	23,313,498	23,972,410	15,331,863
Anthracite and coke	1,196,867	1,644,424	1,535,614	1,335,286	353,315
Anthracite alone	31,273	30,091	25,072	36,268	1,694
Charcoal	337,529	352,928	433,007	437,397	249,146
	16,497,033	22,992,380	25,307,191	25,781,361	15,936,018

TOTAL PRODUCTION OF PIG IRON.

The following table shows the production of pig iron in the United States as far as has been recorded. The statistics for 1854 and all succeeding years were collected by the American Iron and Steel Association; those for 1810, 1840, and 1850 are census figures; those for the other years are largely estimates by early statisticians.

Production of pig iron in the United States, 1810–1908, in long tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1810	53,908	1863	846,075	1887	6,417,148
1820	20,000	1864	1,014,282	1888	6,489,738
1828	130,000	1865	831,770	1889	7,603,642
1829	142,000	1866	1,205,663	1890	9,202,703
1830	165,000	1867	1,305,023	1891	8,279,870
1831	191,000	1868	1,431,250	1892	9,157,000
1832	200,000	1869	1,711,287	1893	7,124,502
1840	286,903	1870	1,665,179	1894	6,657,388
1842	215,000	1871	1,706,793	1895	9,446,308
1846	765,000	1872	2,548,713	1896	8,623,127
1847	800,000	1873	2,560,963	1897	9,652,680
1848	800,000	1874	2,401,262	1898	11,773,934
1849	650,000	1875	2,023,733	1899	13,620,703
1850	563,755	1876	1,868,961	1900	13,789,242
1852	500,000	1877	2,066,594	1901	15,878,354
1854	657,337	1878	2,301,215	1902	17,821,307
1855	700,159	1879	2,741,853	1903	18,009,252
1856	788,515	1880	3,835,191	1904	16,497,033
1857	712,640	1881	4,144,254	1905	22,992,380
1858	629,548	1882	4,623,323	1906	25,307,191
1859	750,560	1883	4,595,510	1907	25,781,361
1860	821,223	1884	4,097,868	1908	15,936,018
1861	653,164	1885	4,044,526		
1862	703,270	1886	5,683,329		

PRICES OF PIG IRON.

In the following table are given the average monthly prices of the principal kinds of pig iron for 1907 and 1908:

Average monthly prices of pig iron, 1907 and 1908, by kinds.

Month.	1907.				1908.			
	No. 2 foundry pig iron at Philadelphia.	Basic pig iron at Philadelphia.	Gray forge pig iron at Pittsburg.	Bessemer pig iron at Pittsburg.	No. 2 foundry pig iron at Philadelphia.	Basic pig iron at Philadelphia.	Gray forge pig iron at Pittsburg.	Bessemer pig iron at Pittsburg.
January	$26.40	$25.25	$22.58	$23.35	$18.20	$17.10	$17.00	$19 00
February	26.37	25.12	22.20	23.25	18.25	17.25	15.99	17.90
March	25.87	25.37	21.76	22.95	18.12	17.25	15.90	17.86
April	25.56	24.56	21.72	23.55	17.65	17.25	15.45	17.49
May	25.60	24.75	22.88	24.05	16.94	16.37	14.90	16.96
June	24.75	24.37	23.15	24.50	16.62	15.50	14.90	16.90
July	23.12	23.12	22.96	23.80	16.50	15.10	14.90	16.83
August	22.00	20.80	21.90	22.95	16.50	15.00	14.71	16.26
September	20.69	19.09	21.15	22.85	16.62	15.44	14.46	15.90
October	19.90	18.40	20.40	22.90	16.75	15.80	14.40	15.75
November	18.94	17.81	19.17	20.35	17.00	16.19	14.90	16.59
December	18.44	17.37	18.40	19.60	17.25	16.70	15.25	17.40

PRODUCTION OF STEEL BY STATES AND KINDS.

The year 1908 marks an epoch in steel making, as during this year the production of open-hearth steel passed that of Bessemer steel. The production of both, however, was much lower than the productions of several years past.

The following table shows the production of Bessemer steel ingots and castings in the leading States from 1904 to 1908, inclusive:

Production of Bessemer ingots and castings, 1904–1908, by States, in long tons.

State.	1904.	1905.	1906.	1907.	1908.
Pennsylvania	3,464,650	4,491,445	4,827,725	4,351,841	2,106,382
Ohio	2,050,115	3,131,149	3,769,913	3,636,679	1,955,446
Illinois	1,257,190	1,651,250	1,684,772	1,723,073	1,237,747
Other States	1,087,185	1,667,531	1,993,420	1,955,956	817,180
	7,859,140	10,941,375	12,275,830	11,667,549	6,116,755

In the following table is given the production of open-hearth steel ingots and castings in the leading States from 1904 to 1908, inclusive:

Production of open-hearth steel ingots and castings, 1904–1908, by States, in long tons.

State.	1904.	1905.	1906.	1907.	1908.
New England	195,901	239,282	251,047	239,797	158,417
New York and New Jersey	165,986	348,072	553,186	706,019	350,348
Pennsylvania	4,306,498	6,471,818	7,718,213	7,868,353	5,322,229
Illinois	358,215	617,625	884,472	1,013,251	483,104
Ohio	480,906	687,392	818,683	819,642	525,171
Other States	400,660	607,187	754,812	902,674	997,460
	5,908,166	8,971,376	10,980,413	11,549,736	7,836,729

The following table gives the production, by States, of basic and acid open-hearth steel ingots and castings in 1908:

Production of basic and acid open-hearth steel ingots and castings in 1908, by States, in long tons.

State.	Basic open-hearth steel.	Acid open-hearth steel.	Total.
New England	112,037	46,380	158,417
New York and New Jersey	307,738	42,610	350,348
Pennsylvania	4,822,215	500,014	5,322,229
Illinois	477,615	5,489	483,104
Ohio	477,068	48,103	525,171
Other States	943,752	53,708	997,460
	7,140,425	696,304	7,836,729

The following table gives the production of all kinds of steel ingots and castings in 1907 and 1908:

Production of all kinds of steel ingots and castings in 1907 and 1908, by States, in long tons.

State.	1907.				1908.			
	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.
Massachusetts, Rhode Island, and Connecticut	1,421	239,797	3,980	245,198	837	158,417	3,344	162,598
New York and New Jersey	858,681	706,019	37,969	1,602,669	351,794	350,348	19,911	722,053
Pennsylvania	4,351,841	7,868,353	88,750	12,308,944	2,106,382	5,322,229	37,254	7,465,865
Delaware, Maryland, District of Columbia, Virginia, West Virginia, Kentucky, Georgia, and Alabama	840,865	412,656	1,900	1,255,421	375,756	499,096	.....	874,852
Ohio	3,636,679	819,642	1,690	4,458,011	1,955,446	525,171	1,172	2,481,789
Indiana and Illinois	1,723,073	1,194,913	6,251	2,924,237	1,237,747	650,403	4,736	1,892,886
Other States	254,989	308,356	4,769	568,114	88,793	331,065	3,346	423,204
	11,667,549	11,549,736	145,309	23,362,594	6,116,755	7,836,729	69,763	14,023,247

TOTAL PRODUCTION OF STEEL.

The statistics of the production of various kinds of steel, as far as has been recorded, are given in the following table. The first steel produced in this country was probably made in Connecticut in 1728 by Samuel Higley and Joseph Dewey. Crucible steel was first successfully produced in the United States in 1832 at the works of William and John H. Garrard, at Cincinnati, Ohio. Bessemer steel was first made in this country in September, 1864, by William F. Durfee at an experimental plant at Wyandotte, Mich., and open-hearth steel in 1864 by the New Jersey Steel and Iron Company at Trenton, N. J.

Production of steel in the United States, 1810–1908, in long tons.

Year.	Bessemer.	Open-hearth.	Crucible.	Other steel.	Total.
1810	.....	.....	917		917
1860	.....	.....	11,838		11,838
1863	.....	.....	8,075		8,075
1864	.....	.....	9,258		9,258
1865	.....	.....	13,627		13,627
1866	.....	.....	16,940		16,940
1867	2,679	.....	16,964		19,643
1868	7,589	.....	19,197		26,786
1869	10,714	893	19,643		31,250
1870	37,500	1,339	29,911		68,750
1871	40,179	1,785	31,250		73,214
1872	107,239	2,679	26,125	6,911	142,954
1873	152,368	3,125	31,059	12,244	198,796
1874	171,369	6,250	32,436	5,672	215,727
1875	335,283	8,080	35,180	11,256	389,799
1876	469,639	19,187	35,163	9,202	533,191
1877	500,524	22,349	36,098	10,647	569,618
1878	653,773	32,255	38,309	7,640	731,977
1879	829,439	50,259	50,696	4,879	935,273
1880	1,074,262	100,851	64,664	7,558	1,247,335
1881	1,374,247	131,202	80,145	2,720	1,588,314
1882	1,514,687	143,341	75,973	2,691	1,736,692
1883	1,477,345	119,356	71,835	4,999	1,673,535
1884	1,375,531	117,515	53,270	4,563	1,550,879
1885	1,519,430	133,376	57,599	1,515	1,711,920
1886	2,269,190	218,973	71,973	2,367	2,562,503
1887	2,936,033	322,069	75,375	5,594	3,339,071
1888	2,511,161	314,318	70,279	3,682	2,899,440
1889	2,930,204	374,543	75,865	5,120	3,385,732
1890	3,688,871	513,232	71,175	3,793	4,277,071
1891	3,247,417	579,753	72,586	4,484	3,904,240
1892	4,168,435	669,889	84,709	4,548	4,927,581
1893	3,215,686	737,890	63,613	2,806	4,019,995
1894	3,571,313	784,936	51,702	4,081	4,412,032
1895	4,909,128	1,137,182	67,666	858	6,114,834
1896	3,919,906	1,298,700	60,689	2,394	5,281,689
1897	5,475,315	1,608,671	69,959	3,012	7,156,957
1898	6,609,017	2,230,292	89,747	3,801	8,932,857
1899	7,586,354	2,947,316	101,213	4,974	10,639,857
1900	6,684,770	3,398,135	100,562	4,862	10,188,329
1901	8,713,302	4,656,309	98,513	5,471	13,473,595
1902	9,138,363	5,687,729	112,772	8,386	14,947,250
1903	8,592,829	5,829,911	102,434	9,804	14,534,978
1904	7,859,140	5,908,166	83,391	9,190	13,859,887
1905	10,941,375	8,971,376	102,233	8,963	20,023,947
1906	12,275,830	10,980,413	127,513	14,380	23,398,136
1907	11,667,549	11,549,736	131,234	14,075	23,362,594
1908	6,116,755	7,836,729	63,631	6,132	14,023,247

NOTE ON THE VALUE OF THE PRODUCTION OF PIG IRON IN THE UNITED STATES IN 1908.

By W. T. Thom.

The output of pig iron for the calendar year 1908 was reported by James M. Swank, general manager of the American Iron and Steel Association, as 15,936,018 long tons, a decrease of 9,845,343 tons, or 38.19 per cent, as compared with 25,781,361 tons reported for 1907. The approximate value of this output, f. o. b. at furnace, as reported to the United States Geological Survey by the producers of pig iron was $254,321,000, a loss, as compared with $529,958,000, the approximate value for 1907, of $275,637,000, or 52.01 per cent.

An element of difficulty in arriving at an exact valuation of the total pig-iron output is the product of pig iron, ferromanganese, etc., derived from foreign imported ores. The value of this product is very considerable in itself, but it constitutes so small a percentage of the total that it was considered and was treated as negligible in ascertaining the approximate value given above.

The following table gives the quantity and the approximate value of the pig iron produced in the United States in 1907 and 1908, by States:

Quantity and value of pig iron produced in the United States in 1907 and 1908, by States, in long tons.

State.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Alabama	1,686,674	$30,100,000	1,397,014	$17,341,000
Illinois	2,457,768	52,229,000	1,691,944	30,135,000
New Jersey	373,189	7,554,000	225,372	3,370,000
New York	1,659,752	33,097,000	1,019,495	15,879,000
Ohio	5,250,687	106,387,000	2,861,325	47,353,000
Pennsylvania	11,348,549	234,952,000	6,987,191	111,385,000
Tennessee	393,106	7,542,000	290,826	4,011,000
Virginia	478,771	8,963,000	320,458	4,578,000
California, Colorado, Missouri, Washington	468,486	11,628,000	313,071	5,959,000
Connecticut, Massachusetts	19,119	663,000	13,794	479,000
Georgia, Texas	55,825	1,181,000	24,345	406,000
Indiana, Michigan, Minnesota, Wisconsin	758,590	18,829,000	348,096 148,938	6,227,000 2,462,000
Kentucky, Maryland, West Virginia	830,845	16,833,000	294,149	4,736,000
	25,781,361	529,958,000	15,936,018	254,321,000

The following table shows approximately the working out in the pig-iron industry in 1908 of the financial depression of 1907, which resulted, as appears, in a decrease in production of pig iron of more than one-third in quantity and of more than one-half in value.

Decrease in production of pig iron in the United States in 1908 as compared with 1907, by States.

State.	Decrease.		Percentage of loss.	
	Quantity.	Value.	Quantity.	Value.
	Long tons.			
Alabama	289,660	$12,759,000	17.17	42.39
Illinois	765,824	22,094,000	31.15	42.30
New Jersey	147,817	4,184,000	39.61	55.39
New York	640,257	17,218,000	38.58	52.02
Ohio	2,389,362	59,034,000	45.51	55.48
Pennsylvania	4,361,358	123,567,000	38.43	52.59
Tennessee	102,280	3,531,000	26.02	46.82
Virginia	158,313	4,385,000	33.07	48.92
California, Colorado, Missouri, Washington	155,415	5,669,000	33.17	48.75
Connecticut, Massachusetts	5,325	184,000	27.85	27.75
Georgia, Texas	31,480	775,000	56.39	65.62
Indiana, Michigan, Minnesota, Wisconsin	261,556	10,140,000	34.48	53.85
Kentucky, Maryland, West Virginia	536,696	12,097,000	64.60	71.86
	9,845,343	275,637,000	38.19	52.01

These two tables speak so plainly for themselves that further comment seems superfluous, unless it be to remark that Alabama, Tennessee, and Virginia stood the strain better than other important producing States that depend on outside ores.

PRICE PER TON OF PIG IRON.

The following table gives the annual average price per long ton of pig iron for the last twenty years:

Average price per long ton of pig iron in the United States, 1889–1908.

1889	$15.78	1896	$10.47	1903	$19.12
1890	16.43	1897	9.85	1904	14.13
1891	15.50	1898	9.90	1905	16.63
1892	14.32	1899	18.00	1906	19.98
1893	11.90	1900	18.85	1907	20.56
1894	9.76	1901	15.25	1908	15.96
1895	11.14	1902	20.92		

During the twenty years covered by this table, pig iron sold for the lowest average price per ton ($9.76) in 1894 and for the highest average price per ton ($20.92) in 1902; but it must be remembered that the element of freight enters into all these prices except for the years 1907 and 1908. This cost of transportation from producer to consumer may be fairly estimated at about $2 per ton for the whole country. This allowance being made, 1907 appears as the year of approximate maximum price ($20.56) of pig iron f. o. b. at furnace during the last two decades.

Cordial thanks are due to the various firms for the trouble taken by them in making their reports.

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[a] Numbers of folios containing important articles on iron ores are printed in italics.

MANGANESE ORES.

By E. C. Harder.

INTRODUCTION.

The conditions governing the manganese mining industry showed no improvement in 1908 over those of 1907; in fact, fewer mines were in operation during 1908 than in the previous year. Manganese ores were mined in Arkansas, California, South Carolina, and Virginia, but only from Virginia were any shipments reported. Eleven mines were in operation during the year, and of these seven shipped a part or all of their product amounting to 6,144 long tons. The Virginia shipments were nearly all from the Blue Ridge district. With the exception of about 30 tons used in the steel industry, all the ore mined was used for chemical purposes, largely in brick manufacture. The percentage of metallic manganese in the domestic ores produced in 1908 varied from 40 to 50 per cent.

As in 1907, the imports far exceeded the domestic production and amounted to 178,203 long tons, most of which was used in the manufacture of ferromanganese and spiegeleisen. A considerable quantity of imported ore is used in the manufacture of dry cells, and a small quantity is used for coloring purposes.

In addition to the 6,144 tons of domestic ore shipped, 4,345 tons were mined and remained as stock at the mines at the end of the year. At a few localities, the operations consisted only in doing assessment work.

The mines of the northeastern Tennessee region and of the Cave Spring and Cartersville districts in Georgia were idle, and the latter show no prospect of becoming active for several years to come. No manganese ores were shipped in the Western States.

Considerable quantities of manganiferous ores were mined in 1908, including manganiferous iron ores and manganiferous silver ores. The former were of low grade, and, except a small production in Virginia, were not utilized for their manganese content. For the most part, they contained less than 6 per cent metallic manganese and simply yielded a high manganese pig iron. The manganiferous iron ores mined in 1908, amounting to 471,480 long tons, were derived from the Lake Superior district and from Arkansas and Virginia. Manganiferous silver ores were mined in the Western States in connection with lead, zinc, and precious metals. A small quantity (15,973 long tons from Leadville) was used in the manufacture of spiegeleisen, and a larger quantity (39,647 long tons) was reported as being used for flux in the copper and silver smelters. Probably a much greater quantity was used for the latter purpose than has been reported.

The production of manganiferous zinc residuum from New Jersey zinc ores in 1908 amounted to 110,225 long tons, which is considerably greater than the production during any preceding year.

SOURCES OF MANGANESE.

Manganese is obtained from four different classes of materials in the United States, viz, manganese ores, manganiferous iron ores, manganiferous silver ores, and manganiferous zinc residuum. The manganese ores consist of various mixtures of manganese oxides, sometimes containing admixtures of carbonate or silicate of manganese. The manganiferous ores consist of mixtures of manganese minerals with minerals of other metals. Manganiferous zinc residuum is an artificial furnace product consisting of oxides of iron and manganese in a matrix of slag. The following is a list of the principal manganese minerals with their chemical formulæ and manganese content:

List of the principal manganese minerals.

Mineral.	Composition.	Percentage of manganese.
Polianite	MnO_2	63.2
Pyrolusite	MnO_2 n H_2O	60–63
Psilomelane	$MnO_2(MnKBa)O$ n H_2O	45–60
Wad	Hydrous impure mixture of manganese oxides.	Variable.
Manganite	$Mn_2O_3H_2O$	62.4
Braunite	$3Mn_2O_3MnOSiO_2$	69
Rhodochrosite	$MnOCO_2$	47.56
Rhodonite (manganese pyroxene)	$MnOSiO_2$	41.9
Tephroite (manganese olivine)	$2MnOSiO_2$	54.3
Spessartite (manganese garnet)	$3MnOAl_2O_33SiO_2$	33.3

Manganese ores.—Manganese ores may consist of any of the oxides or of the carbonate of manganese, but only the oxides occur in commercial quantities in the United States. Pyrolusite and psilomelane are by far the most important. Wad and braunite are of some importance; manganite is rare. Pyrolusite of the variety polianite has a theoretical manganese percentage of 63.2, and psilomelane of 45 to 60. As they occur in nature, however, the ores generally range from 40 to 50 per cent in metallic manganese. Psilomelane and pyrolusite usually occur intermingled, being generally found as nodular concretions with the two minerals in concentric layers, the psilomelane being amorphous, and the pyrolusite occurring in small parallel needles. In many places nodules of pure pyrolusite occur with similar concentric layering, the successive layers being made up of granular and crystalline or needle-like pyrolusite. Pyrolusite and psilomelane frequently have small admixtures of iron oxides, and in this case they are used in the steel industry. When free from iron, they are very desirable for oxidizing and coloring purposes, but are also extensively used in the steel industry.

Deposits of manganese ore occur in many parts of the United States, but are most abundant in the Appalachian and Piedmont regions, in the southern Mississippi Valley, and on the Pacific coast. Small deposits occur in the New England, Rocky Mountain, and Great Basin regions. The principal producing districts up to the present have been the James River-Staunton River and the Blue Ridge regions in Virginia; the Cave Spring and Cartersville districts in Georgia; the Batesville district in Arkansas; and the Livermore-Tesla district in California. Of minor importance are the New River region in Virginia, the northeastern Tennessee region, the

McCormick region in South Carolina, and the Little Grande district in Utah. Besides these, there are unimportant deposits in many parts of the country which have produced small quantities of ore intermittently. At present active mining and shipping is confined to the Blue Ridge and the James River-Staunton River regions. The manganese ore produced at present is being used in the manufacture of spiegeleisen and ferromanganese, and as a coloring material for bricks, pottery, and other articles.

Manganiferous iron ores.—Manganiferous iron ores consist of a mixture of any oxide or the carbonate of iron with any oxide or the carbonate of manganese. In this country manganiferous iron ores consist largely of limonite or hematite mixed with psilomelane, wad, or pyrolusite, a mixture of limonite and psilomelane being the most common. The iron and the manganese oxides may be intimately intermingled, or they may be coarsely mixed so as to be easily distinguished from each other. Sometimes good-sized pockets of manganese ore occur in deposits of iron ore which are otherwise free from manganese. High-grade manganiferous iron ores are used in the manufacture of spiegeleisen and ferromanganese. Most of the low-grade manganiferous iron ores are not utilized for their manganese, it being generally considered an undesirable constituent.

Manganiferous iron ores occur in the United States chiefly in the New England, Appalachian, and Lake Superior regions, while minor deposits are found in the southern Mississippi Valley and in the Rocky Mountain region. High-grade manganiferous iron ore occurs in the Appalachian region, a small quantity being produced in 1908 in Virginia. Other manganiferous iron ores are being produced in the Appalachian and Lake Superior districts which are so low in manganese that they are classed as iron ores. In the blast furnace they yield a "high manganese" pig iron, which is used for special purposes.

Manganiferous silver ores.—Manganiferous silver ores consist of a mixture of manganese and iron oxides with small quantities of silver sulphide and lead carbonate, and sometimes of gold. As a rule, the iron content exceeds the manganese content, though occasionally manganese may be in excess, and rarely may replace the iron altogether. These ores occur as a capping or gossan above metalliferous sulphide deposits which consist largely of iron, lead, zinc, and silver sulphides in a gangue of quartz or calcite. Locally, rhodonite and rhodochrosite are present in the unaltered ores.

Manganiferous silver ores are divided into three classes, according to their uses. (1) The greater portion of the manganiferous silver ores are used for their silver and lead content. Manganese and iron content often insures those ores a higher price because of their fluxing value. (2) A second class of manganiferous silver ore is too low in silver and lead to be used as a source for these metals, but is sufficiently high in manganese and iron to be used for the manufacture of ferromanganese and spiegeleisen, as is the case with the high-grade manganiferous iron ores already mentioned. (3) There is a third class of manganiferous silver ore too low in silver and lead to be used primarily for these metals and too low in iron and manganese to be used for the manufacture of iron-manganese alloys. This ore is sold to the smelters as flux, the iron and manganese becoming waste products, while the silver and lead content is recovered during the smelting.

Manganiferous silver ores occur in the Rocky Mountain and Great Basin regions, the principal producing locality being Leadville, Colo.

Some of the Leadville ores are used in the manufacture of spiegeleisen. All the other localities produce these ores for fluxing only.

Manganiferous zinc residuum.—Manganiferous zinc residuum is obtained from zinc volatilizing and oxidizing furnaces using New Jersey zinc ores. The residuum consists largely of iron and manganese oxides, the zinc having been removed by volatilization and collected as zinc oxide. The crude ores consist of franklinite, zincite, and willemite, and are obtained only from the Franklin Furnace district, New Jersey. Small quantities of zinc residuum are used annually in the manufacture of spiegeleisen.

USES OF MANGANESE.

The uses of manganese in the industries may be classified as follows: (1) Metallurgical, in the manufacture of alloys and in copper, lead, and silver reduction; (2) chemical, as an oxidizer and as a coloring material.

Metallurgical uses.—The manganese ores used in the manufacture of alloys are dependent in value on the percentage of metallic manganese present and on the absence of injurious substances, like silicon, phosphorus, and sulphur. The latter condition is especially necessary in the case of the alloys with iron. Spiegeleisen and ferromanganese are alloys of iron and manganese. The former contains below 20 per cent manganese, while the latter has a manganese content ranging from 20 to 90 per cent. Above 90 per cent the alloy becomes unstable. Silicon and carbon are present in varying quantities. When spiegeleisen is high in silicon, it is known as silicospiegel, and when ferromanganese contains a large percentage of silicon it is known as silicomanganese. Spiegeleisen and ferromanganese are used in the manufacture of steel in the following ways: (*a*) As reducers of iron oxide in the final melting by the formation of manganese oxide, which goes into the slag; (*b*) as recarburizers of steel by the addition of the carbon contained in them and by preventing the further oxidation of the latter; (*c*) for counteracting the effects of phosphorus and sulphur; and (*d*) in the manufacture of manganese steel used for railroad and street-car rails on curves, for car wheels, for burglar-proof safes, for ore chutes and screens, for dipper teeth on steam shovels, for ore crushers, for dredger pins, for cover plates on large electro-magnets used for lifting, for various agricultural implements, and for many other purposes. The use of manganese steel is extending year by year. It is noted for its hardness, ductility, and strength.

Manganese is also used to form alloys with copper, zinc, aluminum, tin, lead, magnesium, and silicon, and with various combinations of these metals. Certain alloys of manganese, aluminum, and copper, known as Heusler's alloys, have come into prominence recently on account of their magnetic properties, and are being extensively experimented on.

Manganese oxides are used to a slight extent in copper, lead, and silver reduction as a substitute for iron oxides.

Chemical uses.—As an oxidizer, manganese oxide is used in the manufacture of chlorine, bromine, and oxygen, and of disinfectants like potassium permanganate; as a drier in paints and varnishes; an a decolorizer of glass, and in the dry cell and Leclanche battery. In these cases, the value of the ore depends on its available oxygen cos-

tent—that is, on its percentages of pyrolusite or manganese peroxide. Of these uses, the most important consists in the manufacture of dry cells in which powdered pyrolusite is used as a coating on one side of the paper disks which compose the cell, the other side of the disks being tinned.

As a coloring material, manganese is used in calico dyeing; for coloring bricks, glass, and pottery, and in the manufacture of green and violet paints. A large percentage of the fancy bricks placed on the market are colored by manganese oxide. When finely powdered, manganese oxide changes the color of red bricks to brown and of buff bricks to gray, and, when coarsely crushed, produces speckled bricks.

Compounds of manganese are used in a small way for medicine, and the mineral rhodonite, a silicate of manganese, is used rarely for ornamental purposes on account of its beautiful pink color.

MANGANESE ORE INDUSTRY.

PRODUCTION.

Manganese ores.—The production of manganese ores in 1908, amounting to 6,144 long tons, was greater than in 1907, though somewhat less than in 1906. Toward the close of 1902 there occurred a sudden drop in production due to the cessation of mining operations in northwestern Georgia. Following this decline there was a steady increase from 2,825 tons in 1903 to 6,921 tons in 1906, since which time the production has again decreased.

The entire production in 1908 was from Virginia. Some manganese ore was mined in South Carolina, Arkansas, and California, but none was shipped. No operations were reported from Tennessee, Georgia, or Utah.

The following table shows the quantity, value, and average price per ton of the manganese ore produced in the different States from 1906 to 1908, inclusive:

Production of manganese ore in the United States, 1906–1908, by States, in long tons.

State.	1906.			1907.			1908.		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Arkansas	62	$290	$4.68	.....	.....	.....	.....	.....	.....
California	1	20	20.00	100	$600	$6.00	.....	.....	.....
South Carolina	.....	.....	.....	800	4,800	6.00	.....	.....	.....
Tennessee	30	300	10.00	100	1,500	15.00	.....	.....	.....
Utah	800	10,000	12.50	.....	.....	.....	.....	.....	.....
Virginia	6,028	77,522	12.86	4,604	56,469	12.27	6,144	$62,779	$10.22
	6,921	88,132	12.73	5,604	63,369	11.31	6,144	62,779	10.22

The following table shows the total production of manganese ore in the United States, by States, as compiled from previous volumes of Mineral Resources. The production previous to 1880 is only approximate, but probably did not exceed 50,000 long tons. The table shows Arkansas, Georgia, and Virginia as the principal producers, California as a steady producer but only of small quantities, and the other States as producing small quantities of ore intermittently.

Production of manganese ore in the United States, 1838–1908, in long tons.

Year.	Alabama.	Arkansas.	California.	Georgia.	Indian Territory, Michigan, Missouri, Montana, and Nevada.	North Carolina.
1838–1879		410				
1866–1879				19,950		
1867–1879			5,500			
1880				1,800		
1881		100		1,200		
1882		175		1,000		
1883		400				
1884		800				
1885		1,483	200	2,580	(Nev.) 200	
1886	75	3,316	100	6,041	(Nev.) 30	14
1887		5,651		9,024		14
1888		4,312	1,500	5,568	(Mich.) 100	
1889		2,528	53	5,208	(Nev.) 15	47
1890		5,339	386	749	(Nev.) 100	14
1891		1,650	705	3,575	(Ind.T.) 206	
1892		6,708		826		
1893		2,020	400	724		
1894		1,934	278	1,277		
1895		2,991	525	3,856		
1896		3,421	284	4,085		2
1897		3,240	484	3,332	(Mich.) 37	
1898	22	2,662	541	6,689		
1899		356	115	3,089	(Mo.) 16	90
1900		145	131	3,447	(Mont.) 137	
1901	17	91	610	4,074	(Mo.) 28	
1902		82	846	3,500		
1903			16	500		
1904			60			
1905			1	150		
1906		62	1			
1907			100			
1908						
Total	114	49,876	12,836	92,244	869	181

Year.	Pennsylvania, South Carolina, and South Dakota.	Tennessee.	Utah and Vermont.	Virginia.	West Virginia and other States.	Total.
1838–1879						410
1866–1879						19,950
1867–1879				18,000		23,500
1880				3,661	300	5,761
1881				3,295	300	4,895
1882				2,982	375	4,532
1883				5,355	[a] 400	6,155
1884				8,980	[a] 400	10,180
1885				18,745	50	23,258
1886		50		20,567		30,193
1887				19,835		34,524
1888	(Pa.) 22			17,646	[b] 50	29,198
1889	(S. C.) 124	30	(Vt.) 1,576	14,616		24,197
1890				12,699		[c] 19,287
1891	(S. Dak.) 19		(Vt.) 49	16,248		[c] 22,452
1892				6,079		13,613
1893		482		4,092		7,718
1894		922		1,797	(W.Va.) 100	6,308
1895	(Pa.) 460			1,715		9,547
1896	(Pa.) 265			2,018	(W.Va.) 13	10,088
1897	(Pa.) 354	11		3,650		11,108
1898		381		5,662		15,957
1899	(Pa.) 12	19		6,228	(W.Va.) 10	9,935
1900		30		7,881		11,771
1901		400	(Utah) 2,500	4,275		11,995
1902	(S. C.) 8			3,041		7,477
1903	(S. C.) 25		(Utah) 483	1,801		2,825
1904			(Utah) 32	3,054		3,146
1905		20		3,947		4,118
1906		30	(Utah) 800	6,028		6,921
1907	(S. C.) 800	100		4,604		5,604
1908				6,144		6,144
Total	2,089	2,475	5,440	234,645	1,998	402,767

[a] Georgia and North Carolina.
[b] Nevada, North Carolina, South Carolina, Tennessee, and Vermont.
[c] Colorado production of 1890 and 1891 published formerly as manganese is manganiferous ore and has been transferred to that table.

Stock.—In the following table is shown the stock of manganese ore on hand at the mines December 31, 1908, in the various States:

Stock of manganese ore on hand at the mines, December 31, 1908, by States, in long tons.

Arkansas	625
California	165
South Carolina	200
Virginia	3,355
	4,345

Manganiferous ores.—The total production of manganiferous ores in the United States in 1908 amounted to 523,034 long tons. All of the ore, except a few hundred tons from Virginia, was mined in the Lake Superior district and in Arkansas and Colorado. Of the Colorado production, 15,973 tons, valued at $39,468, were used in the manufacture of spiegeleisen, while the rest was used for flux in the silver, lead, and copper smelters. All the ore used in steel manufacture was mined at Leadville.

The Lake Superior ores were not used for their manganese content.

The following table gives the quantity, value, average price per ton, and manganese content of the manganiferous ores used in the manufacture of spiegeleisen during the years 1905–1908:

Production of Colorado manganiferous silver ores used in the manufacture of ferromanganese and spiegeleisen, 1905–1908, in long tons.

Year.	Percentage of manganese.	Quantity.	Value.	Average price per ton.
1905	14–41	45,837	$110,497	$2.41
1906	26–36	32,400	97,600	3.01
1907	10–25	67,514	153,328	2.27
1908	22–26	15,973	39,468	2.47
	10–41	161,724	400,893	2.48

The following table gives the quantity, value, average price per ton, and manganese content of the flux ores for 1905 to 1908 in the States from which returns have been received:

Production of manganiferous ores used for fluxing or other purposes in Colorado and Arkansas, 1905–1908, in long tons.

Year.	State.	Percentage of manganese.	Quantity.	Value.	Average price per ton.
1905	Arkansas	28	3,321	$6,642	$2.00
	Colorado	.....	81,738	270,299	3.31
1906	Arkansas	20–25	8,900	24,800	2.79
1907	Arkansas	14	4,133	8,266	2.00
	Colorado	8–26	32,197	[a]97,879	3.04
1908	Arkansas	14	4,066	9,149	2.25
	Colorado	6–22	35,581	83,939	2.36
		6–28	169,936	500,974	2.95

[a] Partly estimated.

The following table shows the total production of all kinds of manganiferous ores in the United States, as far as known. The product

of the Western States is manganiferous silver ore; that of the other States, manganiferous iron ore. The manganiferous silver ores of Colorado, used in the manufacture of spiegeleisen, are separated from those used as flux. The ores from the other Western States were used for fluxing purposes only. All the eastern ores were presumably used in the manufacture of iron-manganese alloys:

Production of manganiferous ores in the United States, 1885–1908, in long tons.

Year.	Arkansas.	Colorado.[a]	Colorado.[b]	Lake Superior region.	Virginia.	Other States.	Total.
1885						(Mont.) [b] 4,263	4,263
1886			[c] 60,000	257,000			317,000
1887			[c] 60,000	210,000	1,025	[d] 726	271,751
1888			[c] 60,000	201,036		[e] 1,096	262,132
1889			64,987	81,359			146,346
1890		[f] 6,397	51,840	61,863			120,100
1891		[f] 964	79,511	132,511			212,986
1892		2,942	62,309	147,431	3,000		215,682
1893	160	5,766	55,962	110,648	1,188	(N. C.) 20	173,744
1894		7,022	31,687	198,466			237,175
1895		13,464	54,163	112,265			179,892
1896		9,072	138,079	329,640			476,791
1897		16,519	149,502	184,585		(Vt.) 1,200	351,806
1898		18,848	99,651	268,862		(Pa.) 100	387,461
1899		29,355	79,855	732,490			841,700
1900		43,303	188,509	334,274			566,086
1901		62,385	228,187	512,084		(N. C.) 20	802,676
1902		13,275	194,132	884,939	3,000		1,095,346
1903		14,856	179,205	566,835	2,802		763,698
1904	600	17,074	105,278	365,572			488,524
1905	3,321	45,837	81,738	720,098			850,994
1906	8,900	32,400	(*g*)	[h] 1,000,000			[h] 1,041,300
1907	4,133	67,514	32,197	314,316			418,160
1908	4,066	15,973	35,581	467,140	274		523,034
	21,180	422,966	2,092,373	8,193,414	11,289	7,425	10,748,647

[a] Manganiferous silver ore used in the manufacture of spiegeleisen and ferromanganese.
[b] Manganiferous silver ore used for flux; mainly from Colorado, but in a few cases probably including other Western States.
[c] Contains some Montana ore.
[d] Georgia 195 tons, Maine 50 tons, and Vermont 481 tons.
[e] North Carolina, South Carolina, and Tennessee 96 tons, and Vermont 1,000 tons.
[f] Published as manganese ore in previous volumes of Mineral Resources.
[g] Not recorded.
[h] Estimated.

Manganiferous residuum from zinc roasting.—The material classed under this head is a residual product from certain zinc oxide works using New Jersey zinc ores. The crude ore consists of a mixture of franklinite, zincite, and willemite, the first being predominant. During the roasting the bulk of the zinc is removed as zinc oxide, and the residuum consists of a mass of manganese and iron oxides. This is used for the manufacture of spiegeleisen and ferromanganese. The following table shows the quantity, value, and average price per ton of manganiferous zinc residuum produced from 1905 to 1908:

Production of manganiferous zinc residuum in the United States 1905–1908, in long tons.

Year.	Quantity.	Value.	Average price per ton.
1905	90,289	$90,289	$1.00
1906	93,461	93,461	1.00
1907	93,413	280,239	3.00
1908	110,225	330,675	3.00
	387,388	794,664	2.05

The following table gives the production of manganiferous zinc residuum in the United States as far as has been recorded:

Production of manganiferous residuum from zinc roasting in the United States, 1889–1908, in long tons.[a]

1889	43,648	1900	87,110
1890	48,560	1901	52,311
1891	38,228	1902	65,246
1892	31,859	1903	73,264
1893	37,512	1904	68,189
1894	26,981	1905	90,289
1895	43,249	1906	93,461
1896	44,935	1907	93,413
1897	33,924	1908	110,225
1898	48,502		
1899	65,010		1,195,916

PRICES.

The prices of manganese ores used in the steel industry vary from $5 to $15 per long ton, according to the grade of the ore. They are governed by the following schedule of prices established by the Carnegie Steel Company:

Schedule of prices paid per ton of 2,240 pounds for domestic manganese ore delivered at Pittsburg or Bessemer, Pa., and South Chicago, Ill.

Prices are based on ores containing not more than 8 per cent silica or 0.25 per cent phosphorus, and are subject to deductions as follows: For each 1 per cent in excess of 8 per cent silica there shall be deduction of 15 cents per ton; fractions in proportion.

For each 0.02 per cent, or fraction thereof, in excess of 0.25 per cent phosphorus, there shall be a deduction of 2 cents per unit of manganese per ton.

Percentage of metallic manganese in ore.	Price per unit, in cents.	
	Manganese.	Iron.
Over 49	30	6
46 to 49	29	6
43 to 46	28	6
40 to 43	27	6

Ores containing less than 40 per cent manganese or more than 12 per cent silica or 0.27 per cent phosphorus are subject to acceptance or refusal at the buyer's option.

Settlements are based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken being deducted from the weight.

The manganese ores for oxidizing and coloring purposes are valued according to the quantity of manganese peroxide present, their consistency, etc., and prices range up to $25 per ton for the better grades of ore. Manganiferous ores used in steel manufacture and for fluxing range in price upward from $2 per ton.

IMPORTS.

During 1908 there were imported into the United States 178,203 long tons of manganese ore, valued at $1,350,223; the imports in 1907 amounted to 209,021 tons, valued at $1,793,143, a decrease in

[a] The manufacture of spiegeleisen from manganiferous residuum was begun in 1870, but there is no record of the tonnage of raw material used prior to 1889.

both quantity and value for the imports during 1908. On account of the small domestic production and the small portion even of this product used in making spiegeleisen and ferromanganese, the importation of foreign manganese ores is a matter of increasing importance as the iron and steel industry in this country develops. By far the larger portion of the imported manganese ore was obtained from India, where large deposits have been developed in the last few years and new ones are still being found. Brazil furnished considerable ore, and small quantities were imported from Cuba, France, Japan, and Germany.

The following tables, compiled from statistics furnished by the Bureau of Statistics, Department of Commerce and Labor, show the imports of manganese ore into the United States from different countries and by ports of entry for 1906, 1907, and 1908:

Imports of manganese ores into the United States, 1906–1908, by countries, in long tons.

Country.	1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Brazil	30,260	$300,466	52,922	$522,510	17,150	$163,561
Russia	13,805	109,814	1,000	19,570	250	4,599
British India	154,180	939,984	95,300	552,228	143,813	912,646
Cuba	11,701	117,050	30,006	262,847	1,469	13,489
Other East Indies			12,552	82,832	7	170
France			1,588	31,536	5,546	75,857
Netherlands			1,795	35,473	761	11,265
Japan	2,000	21,664	1,787	15,020	3,336	41,930
Germany	4,386	112,511	6,702	150,388	2,620	62,045
United Kingdom	1,330	37,711	3,999	96,833	2,973	59,092
Canada	112	1,125	16	500	73	1,245
Spain						24
Belgium	1,710	30,377	1,354	23,406	202	4,214
All other countries	1,776	25,341			3	86
	221,260	1,696,043	209,021	1,793,143	178,203	1,350,223

Manganese ores imported into the United States, 1906–1908, by customs districts, in long tons.

Customs districts.	1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Philadelphia, Pa	93,590	$682,485	106,494	$888,239	68,491	$504,094
Baltimore, Md	120,051	860,112	92,331	694,732	103,043	724,913
New York, N. Y	6,802	136,037	7,867	177,323	5,963	105,665
Chicago, Ill	239	10,096	266	11,839		
Boston, Mass	5	209			5	280
New Orleans, La	411	3,675	1,949	16,539	232	2,752
All others	162	3,429	114	4,471	469	12,519
	221,260	1,696,043	209,021	1,793,143	178,203	1,350,223

The following table shows the total quantity of manganese ore imported into the United States, as far as has been recorded. The figures from 1868 to 1888 represent imports from Canada only; those from 1889 to the present time represent total imports.

Imports of manganese ore into the United States, 1868–1908, in long tons.

Year ending—	Quantity.	Year ending—	Quantity.
June 30—		December 31—Continued.	
1868	1,017	1889[a]	4,286
1869	488	1890	34,154
1870	1,402	1891	28,825
1871	1,056	1892	58,572
1872	1,206	1893	68,113
1873	838	1894	44,655
December 31—		1895	86,111
1873	1,031	1896	31,489
1874	782	1897	119,961
1875	203	1898	114,885
1876	412	1899	188,349
1877	891	1900	256,252
1878	626	1901	165,722
1879	1,886	1902	235,576
1880	2,179	1903	146,056
1881	1,704	1904	108,519
1882	894	1905	257,033
1883	1,326	1906	221,260
1884	603	1907	209,021
1885	1,684	1908	178,203
1886	1,818		
1887	1,630		[b] 2,581,900
1888	1,182		

[a] Figures prior to 1889 represent imports from Canada only, total importations from other countries for these years not being obtainable.
[b] This total duplicates the importation from January 1 to June 30, 1873.

WORLD'S PRODUCTION.

The following table gives the latest available statistics with regard to the world's production of manganese ore. The unit is either the long or the metric ton, except for Canada, where the short ton is used.

World's production of manganese ores.

Country.	Year.	Quantity.	Country.	Year.	Quantity.
North America:		*Tons.*	Europe—Continued.		*Tons.*
United States	1908	6,144	Portugal	1906	22
Cuba	1907	34,171	Russia	1906	1,016,000
South America:			Spain	1906	63,000
Brazil[a]	1905	233,950	Sweden	1907	4,300
Chile	1905	1,324	Turkey[a]	1905	28,600
Europe:			Norway	1904	22
Austria	1907	16,800	Asia:		
Bosnia and Herzegovina	1906	7,651	India	1908	588,318
Hungary	1906	11,000	Japan	1906	13,000
France	1907	18,200	Java	1905	1,600
Germany	1907	75,000	Oceania:		
Greece	1906	10,000	Queensland	1906	1,130
Italy	1907	3,700	New Zealand	1906	16
United Kingdom	1907	16,400			

[a] Exports.

OCCURRENCE OF MANGANESE ORES.[a]

NEW ENGLAND AND NEW YORK.

Vermont.—Manganese ore occurs in Otter Creek valley, Vermont, near the towns of Brandon and South Wallingford. In both localities the deposits are on the west slope of the Green Mountains, at

[a] For detailed descriptions of deposits, see Manganese Ores: Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, pp. 91–101.

or near the contact of a Lower Cambrian quartzite with an overlying Cambrian limestone. The quartzite forms ridges along the west slope of the mountains, and the limestone underlies Otter Creek valley to the west, their contact being near the base of the mountains. The beds strike almost north and south and have a nearly vertical dip, though locally they dip slightly to the west.

The deposits consist mainly of brown iron ore with subordinate manganese ore, occurring in pockets or lumps in variegated clay adjacent to the limestone-quartzite contact. Generally, the iron and manganese ores are intermixed irregularly in the same pockets, but locally they occur in separate pockets and lumps. The iron ores predominate in most places. The manganese is in the form of black, amorphous psilomelane or crystalline pyrolusite, the latter generally occurring in nests and as cavity fillings in the former.

Minor deposits.—Rhodonite, associated with wad derived from it by its oxidation, occurs in many places through the New England crystalline area. The best known localities are Blue Hill, Me., and Cummington, Mass. Bog-manganese deposits occur in western Maine, in New Hampshire, and in southeastern New York. Manganiferous iron ores similar to the Vermont deposits are found in western Massachusetts and Connecticut and in southeastern New York.

No manganese ore has been shipped from New England for many years, and none has been shipped from New York.

PIEDMONT REGION.

Franklin Furnace.—Deposits of manganiferous zinc ore occur as nearly vertical veins in crystalline limestone near Franklin Furnace and Ogdensburg, Sussex County, N. J. Associated with the limestone are bands and lenses of gneiss, pegmatite veins, granite and syenite intrusions, and trap dikes.

The ores consist largely of franklinite, willemite, and zincite with smaller quantities of tephroite, garnet, and rhodonite. The principal gangue mineral is calcite. These minerals vary in abundance in different parts of the veins, sometimes one, sometimes another being predominant. The crude ores are concentrated and separated into three classes, the first consisting largely of franklinite, the second of franklinite and manganiferous silicates, and the third largely of willemite and zincite. The first and second classes of ore are used for manufacturing zinc oxide; the third is used in the production of high-grade spelter. The residuum which remains as clinker in the furnace after the zinc has been volatilized from the first two products consists chiefly of iron and manganese oxides with some silica. It is naturally much higher in iron and manganese than the crude ores. The clinker resulting from the second class of ores is too high in silica to be utilized, but that resulting from the first class is sent to iron blast furnaces and used in the manufacture of spiegeleisen.

James River–Staunton River region.—The manganese area of the James River–Staunton River region, Virginia, occupies a narrow northeast-southwest strip about 75 miles long, extending from Lynchburg northeast along James River to a point beyond Warminster and southwest to Pittsville. Deposits occur along this belt at War-

minster and Midway Mills, Nelson County; Stapleton, Amherst County; Mount Athos, Evington, Otter River, and Lynch, Campbell County; and Pittsville, Pittsylvania County. Only the deposits at Mount Athos can be considered of any importance at the present time, though in former years the deposits at Warminster were also extensively operated. The rocks of the region consist of residual clay and sand derived by disintegration from crystalline and metamorphic rocks such as granite, gneiss, schist, and crystalline limestone. This material is still in place and often only partially decomposed, so that the texture and structure of the original rocks is still clearly distinguishable.

The ores generally occur along definite, narrow zones which are sometimes half a mile in length. These zones in general run along the contact of decomposed granite and quartzose mica schist. The ores occur in nodular masses, ranging in weight up to 500 pounds, scattered through a yellowish-brown, micaceous clay forming a nearly vertical layer between the decomposed granite and schist, the latter being on the foot wall. They also occur as irregular replacements in the granite near the schist contact. The masses are most abundant and closely packed together at the contact and diminish in abundance on both sides. In the foot-wall schist residuum scattered nodules may be found for a distance of 50 feet or more from the contact, while in the hanging-wall granite the replacement rarely goes more than a few feet from the contact.

The ore is medium soft, granular, or finely crystalline pyrolusite of dark bluish-black color. Frequently quartz occurs with it in veins and small lenses. The ore is of very high quality, containing a large percentage of available oxygen and being free from injurious impurities.

Only three mines, that of the Piedmont Manganese Company near Mount Athos, the Theresa mines near Otter River, and the Saunders mine near Evington were in operation during 1908, and no other mines have been operated for many years.

Minor deposits.—Small deposits of manganese and manganiferous iron ore are scattered through the crystalline and metamorphic rocks of the Piedmont region from Pennsylvania to Georgia. For the most part, the ore is pyrolusite, but locally small deposits of rhodonite and manganiferous garnet occur. In the Kings Mountain region, on the boundary of North Carolina and South Carolina, manganese oxides occur as stains, small veins, and replacements in a series of black schists extending as a narrow belt for about 50 miles in a northeast-southwest direction, crossing the boundary line near Blacksburg, S. C., and Kings Mountain, N. C. No deposits of commercial importance have been found, and no ore has been shipped from this region. Near McCormick, Abbeville County, S. C., there are small deposits of manganese ore associated with residual material derived from micaceous schists. Small quantities of ore have been shipped from this area intermittently, but at present there are no operations.

Other small deposits occur in the crystalline and metamorphic area of Georgia at Mount Airy, Habersham County; Bowersville, Hart County; Blue Ridge, Fannin County; and Draketown, Haralson and Paulding counties. No ore has been produced at any of these localities, and prospecting has shown the deposits to be of small extent.

APPALACHIAN REGION.

Blue Ridge district.—Manganese ore deposits occur along the west foot of the Blue Ridge in Virginia from Front Royal on the north to Roanoke on the south, a distance of about 150 miles. The belt is rarely more than a mile or two in width. The deposits occur scattered at irregular intervals near the foot of the mountains, being more closely grouped in some localities than at others. The same region includes the Blue Ridge iron ore mines, many of which contain some manganese ore, frequently in such quantities as to form a manganiferous iron ore. Similarly, most of the manganese deposits contain some iron, especially near the surface. The following are the principal manganese localities: Front Royal, Warren County; Compton, Kimball, Stanleyton, and Shenandoah, Page County; Elkton and Islandford, Rockingham County; Crimora, Dooms, Lyndhurst, and Stuarts Draft, Augusta County; Vesuvius and Midvale, Rockbridge County; and Lithia, Nace, and Troutville, Botetourt County.

The Blue Ridge extends along the contact between the ancient crystalline and metamorphic rocks of the Piedmont region and the Paleozoic sediments. The latter, although nearly vertical, have a general westward dip on the west slope of the mountains and a more or less irregular dip in the valley to the west.

The following shows the succession of formations:

Section for the Blue Ridge region, west central Virginia.

Cambro-Ordovician:
- Natural Bridge limestone.

Cambrian:
- "Buena Vista" shale.
- Sherwood limestone.
- Lower Cambrian quartzite.
- Lower Cambrian shale and quartzite.

Pre-Cambrian:
- Crystalline and metamorphic rocks.

The Lower Cambrian quartzite occupies the main west slope of the Blue Ridge, the Sherwood limestone and "Buena Vista" shale a gently sloping bench at the base, and the Natural Bridge limestone the valley to the west. For a considerable distance along the west front of the ridge, either or both the Sherwood limestone and the "Buena Vista" shale are absent on account of faulting, and the Lower Cambrian quartzite is in contact with the "Buena Vista" shale or the Natural Bridge limestone. Without regard to the sequence of formations, however, the manganese deposits occur at or near the contact of the quartzite and the overlying formation. Fluviatile deposits of variegated clay, sand, and pebbles, occur in many places on the bench near the foot of the mountains.

The manganese ores occur as local concentration pockets in clays, either residual from the overlying formations or fluviatile. Rarely they penetrate the fissures in the underlying quartzite. They are widely distributed through the Blue Ridge ore belt, but it is only occasionally they are sufficiently concentrated to form workable deposits. In such deposits there are alternating layers, lenses, or irregular bodies of barren and ore-bearing clay.

With regard to texture, the ore is of four varieties, viz: (1) Kidneys of black psilomelane embedded at intervals in clay; (2) irregular masses, often porous, of psilomelane frequently containing layers or nests of crystalline pyrolusite, embedded in clay, which form is frequently assumed by local ore segregations in a manganiferous clay; (3) breccia ore in large masses consisting of sandstone or chert fragments, with either psilomelane or pyrolusite as cementing material; (4) replacements and cavity fillings in sandstone or sandy clay. This type is largely composed of crystalline and granular pyrolusite with associated psilomelane. All of these forms may occur in the same deposit, frequently one body of clay will have a certain type of ore, while an adjacent mass will have another type.

Of the numerous mines along the Blue Ridge in Virginia, only the Happy Creek mine near Front Royal, the Dry Run mine near Compton, the Crimora mine near Crimora, the Lyndhurst mine near Lyndhurst, and the Vesuvius mine near Vesuvius are producing or have recently produced manganese ore.

New River district.—The manganese deposits of the New River region occur in several belts, south of Pulaski, Wytheville, and Marion, in Pulaski, Wythe, and Smyth counties, Va. The ores occur in association with iron ores in residual material derived from the lower part of the Shady limestone and the upper part of the underlying Erwin quartzite. They are generally in large masses mixed with varying quantities of brown iron ore, and contain considerable included sand and clay, or small irregular nodules or fragments disseminated through the clay. The ore is largely in the form of psilomelane. Very little ore has been produced in this district, and in recent years only a few small operations have been carried on.

Northeastern Tennessee region.—The manganese area of northeastern Tennessee is the southward continuation of the Blue Ridge and New River districts of Virginia. The principal deposits are in the Shady Valley, Johnson County, near Unicoi, Unicoi County, and near Newport and Del Rio, Cocke County. Unimportant deposits are found in adjacent parts of North Carolina. The ores occur in association with the lower part of Shady limestone or at the contact of the latter with the underlying Erwin quartzite, the latter being the more common location. They are found in variegated clays and are generally associated with brown iron ores. The ore may be in the form of hard, nodular, or irregular masses, consisting largely of psilomelane, or in the form of irregular pockets of soft, granular pyrolusite or wad.

Cartersville district.—The Cartersville district is situated northeast, east, and southeast of Cartersville, Bartow County, Ga. It has a north and south extent of about 15 miles, while its greatest width is about 2½ miles. Manganese ores are scattered over the entire area, but only locally are they sufficiently concentrated for mining. The principal deposits are the Chumbler Hill and Moccasin mines, east of Whites; the Dobbins mine, Milner-Harris mine, lot 274, the Mayburn mine (lot 303), and lots 305 and 306, northeast of Cartersville; lots 460 and 465, east of Cartersville; and the Stegall property, near Emerson. None of these mines is in operation, though a little digging has recently been done at the Mayburn mine.

The rocks of the district range in age from Pre-Cambrian to Ordovician, with the following general succession:

Succession of rocks for northwestern Georgia.

Cambro-Ordovician:
  Knox dolomite.
Cambrian:
  Conasauga shale.
  Rome formation.
  Beaver limestone.
  Weisner quartzite.
  Ocoee group.
Pre-Cambrian:
  Crystalline and metamorphic rocks.

The manganese ores are associated with residual sand and clay, lying on and derived from the Beaver limestone and the Weisner quartzite, chiefly the latter. They occur in small local pockets, and may be divided according to their texture into four classes: (1) Kidney ore, either amorphous blue psilomelane, or a succession of concentric layers of psilomelane and crystalline and granular pyrolusite; (2) irregular masses, either psilomelane or a mixture of psilomelane and pyrolusite; (3) breccia and replacement ore with chert or sandstone fragments; and (4) seams and irregular pockets of soft ore with local hard masses. The clays in which the ore occurs are yellowish brown or a dark red according as they are derived from the Weisner quartzite or Beaver limestone. The breccia ores are associated with residual sandstone or chert masses in the clay.

Cave Spring district.—The Cave Spring district is situated southwest, south, and east of Cave Spring, Floyd County, Ga. The area has a length of about 10 miles in a northeast-southwest direction and a maximum width of 4 miles. The principal deposits are at Reynolds Mountain, east of Cave Spring, at the Lowe mine and the Sanders property, south of Cave Spring, and on the Scarboro tract, southwest of Cave Spring. The ores are associated with residual clays on the surface of the Knox dolomite. These are of two varieties—dark red and crumbly, where residual from limestone, and light-colored, variegated, and plastic, where derived from associated shales. In the red clays, the ore occurs as (1) cement in residual masses of chert breccia; (2) in porous, irregular masses ranging in size up to a foot in diameter; and (3) as pellet ore, consisting of small pealike particles disseminated through the clay. In the variegated clays, the ore occurs as (1) cement in masses of sandstone breccia, or (2) as blue psilomelane kidney ore.

No mines have been operated in recent years in this district.

Minor deposits.—Small deposits of manganese ore occur in many places in the Appalachian region outside of the districts described. In Pennsylvania they occur in association with brown iron ores at Ironton and other places in Lehigh, Berks, and Northampton counties, and at Mount Holly Springs and other places in Cumberland and Franklin counties. Ores are also reported from Blair, Center, and Huntingdon counties in the central part of the State. Manganese ores occur in small quantities in association with the Oriskany iron ores in western Virginia. They are most abundant in Great North Mountain and Massanutten Mountain in Shenandoah and Frederick

counties, and occur to a less extent in Botetourt, Alleghany, and Craig counties, and in localities to the southwest. In Tennessee small deposits are found associated with brown iron ores near Morristown, Hamblen County, and near Sweetwater, Monroe County, in red residual clay derived from the Knox dolomite Small deposits are reported from Chilhowee Mountain. In Georgia manganese ores occur in small quantities at Tunnel Hill, Whitfield County, and near Rome and Lindale, Floyd County, in residual clays derived from the Knox dolomite. With them iron ores are found to a greater or less extent. Unimportant deposits of manganese are found in Cherokee and Cleburne counties, Ala.

LOWER MISSISSIPPI VALLEY AND GULF REGION.

Batesville district.—The Batesville manganese district is situated in north central Arkansas, north of Batesville, Independence County. The White River flows immediately west and south of the district. The region is a short distance west of the Mississippi flood plain and is underlain by rocks ranging in age from Ordovician to Carboniferous. The following section shows the part of the succession in which the manganese deposits occur:

Section in Batesville region of northern Arkansas.

Mississippian:
  Boone chert with St. Joe limestone member.
Devonian (?):
  Chattanooga shale (?) with Sylamore sandstone member (?).
Silurian:
  St. Clair limestone.
Ordovician:
  Cason shale
  Polk Bayou limestone,
  Izard limestone,
  St. Peter sandstone.

Manganese ores occur in three different associations in the Batesville district, but all the ores are at very nearly the same geologic horizon, namely, at the horizon of the Cason shale, between the Boone chert and the Polk Bayou limestone, or locally the Izard limestone where the Polk Bayou is absent. The St. Clair limestone is generally absent where manganese deposits occur, while the Devonian is doubtfully present in a few places. (1) The Cason shale locally becomes red and sandy and contains an abundance of small lenticular manganiferous iron ore nodules constituting a low-grade manganiferous iron-ore deposit. This bed where exposed is 10 feet or more in thickness. (2) In most of the mines of the district, the horizon normally occupied by the formations given above, between the Boone chert and the Polk Bayou limestone, is occupied by a manganese-bearing bed of varying nature, which appears to be partly residual from the erosion of other rocks formerly occupying this horizon and partly deposition of new material. This bed is also called the Cason shale, and although occupying a wider horizon is presumably equivalent to (1). It varies in thickness from a few inches to many feet, because of the irregular surface of the underlying Polk Bayou limestone. The formation consists sometimes of clay with manganese ore fragments, sometimes of a solid bed of sandy, low-grade ore with

associated sediments, and at other times of a partial replacement of sediments. (3) The remaining forms of manganese deposits are associated with residual clays on the slopes of hills below the main manganese horizon above mentioned. These deposits consist of masses of psilomelane, pyrolusite, wad, and braunite, and are reconcentrations from the manganese bed above.

Only a few deposits have been worked recently, among them the Cason, Reeves, Bales, Roach, and Meeker mines. The principal old mines are the Southern, Polk-Southerd, Turner, Adler, Trent, Baxter, and Montgomery.

Minor deposits.—Small deposits of manganese are reported from Whitfield, Hickman County, Tenn., and from various localities in Missouri, especially in association with the hematite ores of the Pilot Knob region. In west-central Arkansas manganese ores occur in association with the novaculite beds of the Ouachita Mountains. They are at very nearly the same horizon as the Batesville ores, but are of no commercial importance. Near Llano, Llano County, in the pre-Cambrian area of central Texas, there are several extensive veins of manganese silicates, altered superficially to manganese oxide. The minerals are mainly spessartite, tephroite, and rhodonite.

LAKE SUPERIOR DISTRICT.

Much of the iron ore of the Lake Superior district contains between 1 and 10 per cent metallic manganese. It is in the form of oxide, largely pyrolusite, occurring locally as small pockets or intimately mixed with red hematite.

Most of the manganiferous iron ores of the district have come from the Gogebic, Menominee, Mesabi, and Marquette ranges. At present, however, numerous deposits of manganiferous iron ore are being discovered on the Cuyuna range of central Minnesota, where it occurs as local bodies in iron-ore deposits. A small amount of manganese has also been found in the iron-ore deposits of the Baraboo range in southern Wisconsin.

ROCKY MOUNTAIN REGION.

Leadville district.—Manganiferous silver ores occur at Leadville, Colo., in large deposits at or near the contact of porphyry and blue limestone, replacing the latter. These deposits consist of a black mixture of manganese and iron oxides with lead carbonate and silver. The manganese content varies from 10 to 40 per cent, and according as the manganese is high the iron is low, and conversely. Manganese and iron oxides are associated only with the oxidized portions of the Leadville deposits. In the lower unoxidized portions the minerals are mainly pyrite, marcasite, sphalerite, and galena. Manganese minerals are conspicuously absent, and it is believed that the large quantity of manganese oxide in the oxidized ore is due to infiltration from the porphyry. The ore is used in the steel industry and for fluxing.

Little Grande district.—The Little Grande district is located in Grand County, Utah, about 10 miles south of Little Grande, a station on the Rio Grande Western Railroad. The ore occurs here as a replacement of calcareous layers along a certain horizon in the

Triassic sandstone series. Above this horizon are beds of white and gray quartzite; below it are red thin-bedded limestones and calcareous sandstones grading downward into a massive red sandstone, which is probably the Vermilion Cliff sandstone. The ore, consisting of blue granular and crystalline pyrolusite, is found abundantly as float and as replacements of layers and in pockets in the limestone near the surface, where the overlying rocks have been eroded.

Minor deposits.—Manganese occurs in Custer County, S. Dak., as wad in fissures and beds in Carboniferous limestone in association with cave deposits of calcite.

Manganiferous silver ores occur in veins in the Butte granite at Butte, Mont. These veins traverse the area north, west, and south of Butte, nearly surrounding the copper area, in which little or no silver ore occurs. The outcrops and upper portions of the silver veins are black, and consist of a mixture of quartz and manganese oxides, mainly wad, carrying silver. At depth the veins are white and pink and consist of silver and lead sulphides, with some pyrite, chalcopyrite, and locally sphalerite, in a gangue of quartz, rhodonite, and some rhodochrosite. In the Black Rock mine, where the veins are typically developed, the change takes place at a depth of between 150 and 300 feet. The veins vary in width up to 100 feet or more, a large part of them generally being made up of included lenses of granite. The veins are branching and anastomosing, but all have a general east and west direction, ranging between northeast-southwest and southeast-northwest. The manganiferous ores of Butte have been of little value commercially. In a few places the oxidized ore has been mined in former years mainly for its manganese content for use as flux in smelting; but as a rule the ore is mined for its silver.

Manganiferous silver ores similar to the Leadville ore occur at Neihart, Cascade County, and Castle, Meagher County, Mont. The ores are in the form of brown and black oxides and occur in the upper portions of veins which grade down into unaltered sulphide ores of silver. A bog deposit of limonite and wad occurs at Wickes, Jefferson County, Mont.

Manganiferous iron ores are found in the Cebolla district in Gunnison County, Colo. Manganese oxide is here associated with limonite in clay, a surface alteration of an iron carbonate in localities adjacent to a trachyte capping.

Manganiferous and ferruginous silver ores occur in southwestern New Mexico at Kingston and Lake Valley, Sierra County.

Manganese ores are abundantly developed in the oxidized portions of the metalliferous deposits at Tombstone in Cochise County, Ariz. The deposits are in the form of veins or chimneys, the manganese occurring as pyrolusite and earthy black wad, with some psilomelane in the upper portions of these in a calcareous and siliceous gangue.

GREAT BASIN REGION.

A small deposit of manganese occurs 2 miles east of Golconda, Nev. It is bedded and varies in thickness from a few inches to 3 feet, and is interstratified with calcareous and siliceous tufa. There is good evidence that this is a hot-spring deposit in a small basin in the tufa, as supposed vents of the spring are seen on the slopes of the hills above

it. The ore is mainly wad, occurring as a black powder or as small fragments slightly consoliated.

A deposit of manganiferous iron ore has recently been discovered in western Utah near Joy, Juab County. It is said to occur along the contact of a limestone and a granite, the latter being on the foot wall. There has been no production from this area because of lack of railroad facilities.

Manganiferous silver ores occur near Modena, Iron County, and in the Tintic district, Utah. The ores of the Tintic district are used for flux in the local smelters. The ore at Modena consists of a mixture of iron and manganese oxides, the latter largely wad, and occurs in the decomposed limestone on the foot wall of an igneous dike. No ore has been shipped from this locality.

Manganiferous and ferruginous silver ores are found at Pioche, Lincoln County, and at Eureka, Eureka County, Nev.

PACIFIC COAST.

Manganese ore occurs in California in two different associations: (1) In many localities in the Sierra Nevada pyrolusite and psilomelane occur in veins and in replacements in the Calaveras formation; (2) near the coast, north and south of San Francisco, ore occurs as local small, thin lenses interbedded with jaspers of the Franciscan formation. The best known deposits of the first type occur near Meadow Valley, Plumas County, and in Placer, Calaveras, and other counties. Indications of manganese deposits of the second type are found throughout the Franciscan areas of west-central California, and small deposits occur locally. The most important of these found up to the present are located southeast of Livermore in Alameda and Santa Clara counties. Among them are the Old Ladd, Fable, Pennsylvania, and Isler Mountain mines, and the Overacker property.

Other deposits occur at Red Rock Island and Sausalito, near San Francisco; in the Russian River valley, Sonora and Mendocino counties; east of Tres Pinos, San Benito County; and near San Luis Obispo, San Luis Obispo County. The ore is supposed to be largely in the form of manganite and an impure oxide.

The deposits of the Livermore district are of two kinds, fault deposits and interbedded lenses. The only deposit of the first type which is of importance is at the Ladd mine, near Tesla. The fissure averages about 4 or 5 feet in width, with a hanging wall of massive pink jasper and a foot wall of thin-bedded gray jasper and clay. It strikes approximately east and west and dips steeply to the south. Indications of ore are found for nearly half a mile along the strike. The ore occurs as cavity fillings, as infiltrations and replacements in red and yellow clays in the fissure, and as veins and breccia cement in the massive south wall. It is black in color, and hard or soft, according as it is associated with clays or with the jasper wall.

The other deposits of the Livermore district are of the second type. They consist of small lenses ranging up to 100 or more feet in extent, and from a few inches to 5 feet or more in thickness. These lenses appear to be interbedded with the jasper layers, and consist of black, porous ore with seams of quartz. Along the edges there is frequently considerable replacement of chert by manganese oxide.

FERROMANGANESE AND SPIEGELEISEN.

PRODUCTION

The total production of ferromanganese and spiegeleisen in the United States in 1908 was 152,018 long tons, of which 40,642 tons were ferromanganese and 111,376 tons were spiegeleisen. This total shows a decrease of 187,330 tons as compared with the production of 1907, which was 339,348 long tons, of which 55,918 tons were ferromanganese and 283,430 tons were spiegeleisen. Pennsylvania produced 102,699 tons of the total output in 1908, and the rest (49,319 tons) was produced in Illinois and Colorado.

The production of spiegeleisen was begun in the United States in 1870 from the manganiferous residuum of New Jersey zinc oxide works, but the quantity manufactured the first two years has not been recorded. The following table gives the total quantity of ferromanganese and spiegeleisen produced in the United States from 1872 to 1908, inclusive. As ferromanganese and spiegeleisen are included under the production of pig iron, no separate value is assigned to them in this table.

Production of spiegeleisen and ferromanganese in the United States, 1872–1908, in long tons.

1872	4,072	1892	179,131
1873	3,930	1893	81,118
1874	4,070	1894	120,180
1875	6,993	1895	171,724
1876	5,907	1896	131,940
1877	7,897	1897	173,695
1878	9,530	1898	213,769
1879	12,438	1899	219,768
1880	17,503	1900	255,977
1881	18,827	1901	291,461
1882	19,610	1902	212,934
1883	21,941	1903	192,661
1884	30,262	1904	219,446
1885	30,956	1905	289,983
1886	42,841	1906	300,500
1887	42,498	1907	339,348
1888	48,901	1908	152,018
1889	76,628		
1890	133,180		4,211,403
1891	127,766		

PRICES.

The prices of iron-manganese alloys vary with the content of these metals. However, as the alloys are generally made with a fairly definite composition, the prices vary only within small limits.

The following table shows the average range of prices for various iron-manganese alloys during 1908:

Prices per long ton of iron-manganese alloys during 1908.

Alloy.	Approximate percentage of manganese and silicon.	Price.
Ferromanganese [a]	75–80 Mn	$44–$48
Spiegeleisen [a]	15–20 Mn	30– 34
Silicomanganese	70–75 Mn, 20–25 Si	90–125
Silicospiegel [a]	15–20 Mn, 10–12 Si	33– 41

[a] Compiled from weekly tables in the Industrial World, Pittsburg.

IMPORTS.

Important quantities of iron-manganese alloys are imported into the United States annually. The following table gives the quantity and value of spiegeleisen and ferromanganese imported into the United States from 1903 to 1908, by calendar years:

Ferromanganese and spiegeleisen imported and entered for consumption, 1903–1908, in long tons.

Year.	Ferromanganese.		Spiegeleisen.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1903	41,519	$1,699,666	122,015	$2,709,317	163,534	$4,408,983
1904	21,813	707,037	4,623	132,461	26,436	839,498
1905	52,841	1,884,651	55,457	1,336,104	108,298	3,220,755
1906	84,359	4,953,644	103,268	2,942,940	187,627	7,896,584
1907	87,400	5,354,656	48,994	1,399,381	136,394	6,754,037
1908	44,624	1,860,664	4,579	125,054	49,203	1,985,718

The following table gives the quantity of ferromanganese and spiegeleisen imported by fiscal years as far as has been recorded:

Imports of ferromanganese and spiegeleisen into the United States during fiscal years ending June 30, 1884–1908, in long tons.[a]

Year ending June 30—	Ferro-manganese.	Spiegel-eisen.	Total.
1884	94,210		94,210
1885	65,406		65,406
1886	99,426		99,426
1887	150,205		150,205
1888	108,973		108,973
1889	93,032		93,032
1890	108,771		108,771
1891	54,239		54,239
1892	55,080		55,080
1893	49,157		49,157
1894	11,579		11,579
1895	8,127		8,127
1896	66,608		66,608
1897	11,301		11,301
1898	6,346	10,108	16,454
1899	10,392	3,615	14,007
1900	10,684	13,675	24,359
1901	8,995	16,308	25,303
1902	37,618	31,416	69,034
1903	53,121	122,566	175,687
1904	23,903	50,620	74,523
1905	41,166	22,443	63,609
1906	62,064	88,224	150,288
1907	94,543	82,423	176,966
1908	58,101	18,504	76,605
	.....	.....	1,842,949

[a] Imports prior to 1884 not recorded. Estimated quantity imported yearly during the seventies is about 20,000 to 30,000 tons.

GOLD AND SILVER.

By Waldemar Lindgren and H. D. McCaskey.

PRODUCTION.

The production of gold and silver in the United States from domestic ores in 1908 is shown in the following table in distribution by States and Territories:

Approximate distribution by producing States and Territories of the product of gold and silver in the United States for the calendar year 1908, in fine ounces.[a]

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Alabama	1,993	$41,200	400	$200
Alaska	960,669	19,858,800	204,600	109,400
Arizona	120,937	2,500,000	2,900,000	1,551,200
California	935,074	19,329,700	1,703,700	911,300
Colorado	1,106,385	22,871,000	10,150,200	5,429,400
Georgia	2,719	56,200	200	100
Idaho	69,829	1,443,500	7,558,300	4,042,900
Illinois			2,000	1,100
Michigan			294,100	157,300
Missouri			49,400	26,400
Montana	152,865	3,160,000	10,356,200	5,539,500
Nevada	565,475	11,689,400	9,508,500	5,086,100
New Hampshire	179	3,700	6,300	3,400
New Mexico	14,817	306,300	400,900	214,500
North Carolina	4,716	97,500	1,300	700
Oregon	43,823	905,900	56,100	30,000
Philippine Islands	13,763	284,500	1,300	700
Porto Rico	29	600		
South Carolina	2,598	53,700	200	100
South Dakota	374,529	7,742,200	197,300	105,500
Tennessee	179	3,700	60,900	32,600
Texas	24	500	447,000	239,100
Utah	190,922	3,946,700	8,451,300	4,520,600
Virginia	174	3,600	300	200
Washington	12,273	253,700	86,800	46,400
Wyoming	368	7,600	3,500	1,900
	4,574,340	94,560,000	52,440,800	28,050,600

[a] Gold value, $20.671834625323 per fine ounce. Average commercial silver value, 53 cents per fine ounce.

The figures in this table are the result of conference and adjustment between the Bureau of the Mint and the Geological Survey, and are accepted as final by the two bureaus. The basis for this table are data collected by the Bureau of the Mint of bullion deposits in the United States mints and assay offices and statements from the

smelting and refining establishments; the distribution by States is, moreover, checked and verified by the data collected by the Geological Survey directly from the producing mines. The table is derived from three items: (1) The unrefined domestic gold and silver deposited in the United States mints and assay offices; (2) the domestic gold and silver in fine bars reported by the private refineries; (3) the unrefined domestic gold and silver contained in ores, copper matte, etc., exported for reduction. The last is an item of small relative importance.

In addition, gold and silver were produced in the smelters and refineries of the United States from foreign ore, matte, and unrefined bullion as follows: Gold, 892,138 fine ounces, or $18,442,100; silver, 65,107,220 fine ounces, or $34,506,800.

The Mint Bureau does not further subdivide these figures. The foreign gold and silver were derived from Mexico, Canada, nearly all South American and Central American countries, Korea, and Japan; minor amounts were received from other sources. Of the gold, probably about $9,000,000 was derived from Mexico, and about $8,000,000 from Canada. Of the silver, about 45,000,000 fine ounces came from Mexico and about 16,000,000 ounces were derived from Canada.

The gains and losses in the production of the various States and Territories, compared with the production of 1907, are shown in the following table:

Increase (+) or decrease (−) in production of precious metals in the United States in 1908, by States and Territories, in fine ounces.

State or Territory.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
Alabama	+ 668	+ $13,800	− 200	− $200
Alaska	+ 66,245	+1,369,400	+ 25,300	− 8,900
Arizona	− 7,934	− 164,000	− 3,100	− 364,800
California	+119,786	+2,476,200	+ 113,700	− 138,100
Colorado	+ 95,464	+1,973,400	−1,345,200	−2,157,600
Georgia	− 416	− 8,600	− 500	− 400
Idaho	+ 9,075	+ 187,600	− 330,100	−1,163,400
Illinois			− 900	− 800
New Hampshire	+ 179	+ 3,700	+ 6,300	+ 3,400
Michigan			− 37,200	− 61,400
Missouri			+ 24,100	+ 9,700
Montana	− 15,122	− 312,600	− 773,400	−1,806,000
Nevada	−180,032	−3,721,600	+1,228,000	− 379,000
New Mexico	− 1,147	− 23,700	− 198,600	− 181,200
North Carolina	+ 909	+ 18,800	− 23,900	− 15,900
Oregon	− 15,301	− 316,300	− 39,900	− 33,400
Philippine Islands	+ 10,633	+ 219,800	+ 1,200	+ 600
Porto Rico	− 29	− 600		
South Carolina	− 213	− 4,400	+ 100	
South Dakota	+174,344	+3,604,000	+ 90,700	+ 35,100
Tennessee	− 5	− 100	+ 2,600	− 5,900
Texas	− 24	− 500	+ 141,700	+ 37,600
Utah	− 56,836	−1,174,900	−2,955,600	−3,007,900
Vermont			− 3,800	− 2,500
Virginia	− 228	− 4,700	+ 100	+ 100
Washington	− 416	− 8,600	+ 2,800	− 9,000
Wyoming	− 87	− 1,800	+ 1,900	+ 800
	+199,513	+4,124,300	−4,073,900	−9,249,100

The total production of gold in 1908 was 4,574,340 fine ounces, valued at $94,560,000. This is an increase, compared with the production of 1907, of 199,513 fine ounces, corresponding to $4,124,300.

Out of 23 States and Territories contributing to the total gold output 9 showed increases in production in 1908. The greatest gains took place in South Dakota, $3,604,000; California, $2,476,200; Colorado, $1,973,400; and Alaska, $1,369,400. Smaller increases were shown by the Philippine Islands, $219,800, and Idaho, $187,600. Fourteen States and Territories decreased their production of gold in 1908. In Nevada the greatest loss was shown, amounting to $3,721,600; Utah showed a loss of $1,174,900; in the remaining 12 States the losses were smaller, in no case exceeding $350,000.

The production of silver from domestic ores in 1908 amounted to 52,440,800 fine ounces, which had a commercial value of $28,050,600. This was a decrease in quantity, compared with the output of 1907, of 4,073,900 fine ounces, and a decrease in value of $9,249,100. The production was contributed by 26 States and Territories. Of these 13 showed an increase in quantity as compared with the production of 1907. The greatest gain was reported from Nevada, 1,228,000 fine ounces; Texas, 147,700 fine ounces; and California, 113,700 fine ounces. In no other case did the increase reach 100,000 ounces. In 13 States and Territories a decrease in the production of silver was reported as compared with 1907. Heavy losses were shown by Utah, 2,955,600 fine ounces, and Colorado, 1,345,200 fine ounces. Montana also showed a considerable loss, amounting to 773,400 fine ounces. Smaller decreases were reported from Idaho, 330,100 fine ounces, and New Mexico, 198,600 fine ounces. In no other States did the loss reach 100,000 ounces.

The gold-mining industry of the United States had a successful and prosperous year in 1908, in spite of many adverse conditions of trade and finance. Fundamentally this prosperity is due to the fixed price and apparently limitless demand for the product. The immediate causes operating to increase the output were in part the removal of certain abnormal features tending to depress the production in 1907, such as the partial closing of the Homestake mine in the Black Hills of South Dakota and the labor difficulties in the Mother Lode counties of California.

To some degree the increased production of gold was also indirectly due to the closing of many mines in the base-metal camps. A tendency toward increased production by small operators was noted as early as the last months of 1907 and continued through 1908. Large numbers of miners left the districts in which the output of lead, copper, and zinc was curtailed and began placer work or took up leases in gold-mining camps.

The depression in the base-metal industries did not affect the gold production except as above noted, for the total base-metal ores now contribute only 7 per cent to the normal gold output of the country. The gold from copper ores suffered little reduction, but the small amounts contributed from lead and zinc ores were much reduced. Both smelters and refineries drew upon their accumulated stock of base-metal ores and bullion.

The silver-mining industry presents a far less satisfactory condition than that of gold owing to the low prices for silver, lead, copper,

and zinc. During parts of the year the large smelters of Utah and Colorado were closed or were operated with a reduced capacity. Important mines in Leadville, Aspen, Creede, and Park City, which were operating on low-grade ores, found it very difficult to make profits on ore of the same grades that yielded well in 1906 and 1907, and were therefore compelled to reduce their output or to close. Owing to temporary lack of demand from India, the silver market declined almost steadily from about 56 cents per ounce in the early part of the year to about 48 cents in December, the average price being 53 cents. The year closed with New York prices at 50 cents. However, the purchases by India during past years have been large and have steadily increased, and there is no reason to expect a sudden falling off in this market. The extraordinarily heavy production of Canada, mainly from the Cobalt district, which for 1908 is estimated at 22,070,212 ounces, undoubtedly contributed to the depression in the price of silver. A great reduction in the output of silver in the United States was clearly foreshadowed in the figures of the Geological Survey for the mine production in 1907, which amounted to only 52,500,104 fine ounces, whereas the refineries and the mints reported 56,514,700 fine ounces. The shortage in the mine output for the last months of 1907 was naturally reflected in the refinery returns for 1908 and was accentuated by still further reduction in the production of the mines. The smelters and refineries drew again on their accumulated stocks. To the total production of silver in 1908 the copper ores contributed about 29 per cent and the lead ores 30 per cent.

The average commercial value per ounce of silver from 1900 has been as follows: 1900, $0.62; 1901, $0.60; 1902, $0.53; 1903, $0.54; 1904, $0.58; 1905, $0.61; 1906, $0.68; 1907, $0.66; and 1908, $0.53.

PRODUCTION OF GOLD AND SILVER IN UNITED STATES SINCE 1792.

According to tables published by the Director of the Mint the total production of gold and silver in the United States from 1792 to 1908, inclusive, is as follows:

Production of gold and silver in the United States, 1792–1908, by periods, in fine ounces.

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and since by the Director of the Mint.]

Years.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
1792–1847	1,187,170	$24,537,000	309,500	$404,500
1848–1872	58,279,778	1,204,750,000	118,568,200	157,749,900
1873–1908	88,833,231	1,836,344,000	1,664,271,300	1,379,892,200
	148,300,179	3,065,631,000	1,783,149,000	1,538,046,600

The following table, from the report of the Director of the Mint on the production of gold and silver, shows the quantity and value of these metals produced in the United States since 1880:

Production of gold and silver in the United States from 1880 to 1908, inclusive, in fine ounces.

Year.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Commercial value.
1880	1,741,500	$36,000,000	30,318,700	$34,717,000
1881	1,678,612	34,700,000	33,257,800	37,657,500
1882	1,572,187	32,500,000	36,196,900	41,105,900
1883	1,451,250	30,000,000	35,732,800	39,618,400
1884	1,489,950	30,800,000	37,743,800	41,921,300
1885	1,538,373	31,801,000	39,909,400	42,503,500
1886	1,686,788	34,869,000	39,694,000	39,482,400
1887	1,603,049	33,136,000	41,721,600	40,887,200
1888	1,604,478	33,167,500	45,792,700	43,045,100
1889	1,594,775	32,967,000	50,094,500	46,838,400
1890	1,588,877	32,845,000	54,516,300	57,242,100
1891	1,604,840	33,175,000	58,330,000	57,630,000
1892	1,597,098	33,015,000	63,500,000	55,662,500
1893	1,739,323	35,955,000	60,000,000	46,800,000
1894	1,910,813	39,500,000	49,500,000	31,422,100
1895	2,254,760	46,610,000	55,727,000	36,445,500
1896	2,568,132	53,088,000	58,834,800	39,654,600
1897	2,774,935	57,363,000	53,860,000	32,316,000
1898	3,118,398	64,463,000	54,438,000	32,118,400
1899	3,437,210	71,053,400	54,764,500	32,858,700
1900	3,829,897	79,171,000	57,647,000	35,741,100
1901	3,805,500	78,666,700	55,214,000	33,128,400
1902	3,870,000	80,000,000	55,500,000	29,415,000
1903	3,560,000	73,591,700	54,300,000	29,322,000
1904	3,892,480	80,464,700	57,682,800	33,456,000
1905	4,265,742	88,180,700	56,101,600	34,222,000
1906	4,565,333	94,373,800	56,517,900	38,256,400
1907	4,374,827	90,435,700	56,514,700	37,299,700
1908	4,574,340	94,560,000	52,440,800	28,050,600
	75,293,467	1,556,452,200	1,455,851,600	1,128,817,800

IMPORTS AND EXPORTS.

Imports of gold and silver, in ore or base bullion or as refined metals, are recorded by the Bureau of Statistics from a great number of countries. The greater part comes from Mexico and Canada, but almost all of the Central American and South American countries, except Argentina and Brazil, are contained in the list. Many European and Asiatic countries contribute to it.

In 1908 gold was imported from Mexico as follows: In ore and base bullion, $6,189,325; as refined metal, $8,572,261. In the same year silver was imported from Mexico as follows: In ore and base bullion, $18,002,739; as refined metal, $9,007,973.

From the Canadian Pacific provinces the figures are as follows: Gold in ore and base bullion, $4,008,953; refined gold, $2,362,284. Silver in ore or base bullion, $503,996.

From Ontario was imported gold in ore and base bullion, $221,412; refined gold, $247,667; silver in ore and base bullion, $7,598,820; refined silver, $376,112. The figures given for Mexico and the Canadian provinces mentioned add up to $21,354,235 in gold and to $35,489,680 in silver.

The imports from Chile in 1908 were: Gold, $91,865 in ore or base bullion and $54,533 as refined metal; silver, $1,395,226 in ore or base bullion and $203,790 in the refined state.

Complete tables recording the exports and imports in detail are found in the reports of the Director of the Mint on the production of precious metals.

The figures given by the Bureau of Statistics for imports and exports of refined bullion and coin are of course exact; but it will be noted that the data of gold or silver in ore and base bullion do not agree, particularly in the case of Mexico, as detailed above, with the figures of the mints and refineries. The reason is undoubtedly that no account is kept of the minute quantities of gold and silver in blister copper which is imported duty free from foreign countries.

The following table gives a summary of imports and exports of gold and silver during 1908:

Imports and exports of gold and silver during the calendar year 1908.

[Figures furnished by the Bureau of Statistics.]

Description.	Imports.	Exports.	Excess.	
			Imports.	Exports.
GOLD.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Contained in domestic ore		413,223		413,223
Contained in foreign ore	11,930,026	5,842	11,924,184	
Domestic bullion		41,441,298		41,441,298
Foreign bullion	24,120,575	1,147	24,119,428	
United States coin	10,451,327	37,873,095		27,421,768
Foreign coin	3,774,365	1,480,851	2,293,514	
Total	50,276,293	81,215,456	38,337,126	69,276,289
Excess of exports				30,939,163
SILVER.				
Contained in domestic ore		283,257		283,257
Contained in foreign ore	28,054,606		28,054,606	
Domestic bullion		50,208,113		50,208,113
Foreign bullion	11,183,285	840,865	10,342,420	
United States coin	2,518,331	204,401	2,313,930	
Foreign coin	467,908	301,035	166,873	
Total	42,224,130	51,837,671	40,877,829	50,491,370
Excess of exports				9,613,541

MINES REPORT.

METHOD OF COLLECTING STATISTICS.

It should be distinctly understood that the table on a preceding page contains the figures of the production of gold and silver, which are accepted as final by the Geological Survey, inasmuch as they record in the main the quantities of these metals which were actually produced during the calendar year. It is difficult to trace the refined metals back to the States where the ore was produced, and it is still more difficult to trace them back to the producing counties and districts. In order, therefore, to ascertain the state of the mining industry in each mining camp, the Geological Survey asks the owners of each mining property to report the amount of gold and silver, as well as that of other metals produced. Tabulated in proper form, these replies form the basis of this mines report.

The Mint Bureau records the production of the precious metals from gold bullion deposits in United States mints and assay offices, from the fine bars reported by the refineries, and from the gold and silver contained in ores and metallurgical products exported for reduction.

The statistics of gold and silver collected from the mines by the Geological Survey are obtained from the following four items: 1. Gold and silver in placer bullion produced during calendar year. 2. Gold and silver in mill bullion produced in mill of company during calendar year. 3. Gold and silver in base bullion, matte, etc. (by assay value), produced in smelter of company during calendar year. 4. Gold and silver in crude ore and concentrates (by assay value) shipped to custom works in calendar year.

The first item needs no explanation. The second and third items cover the cases of mining companies which have their own reduction works; they report the gold and silver bullion produced during the year, or the gold and silver contained in their metallurgical products sold to refineries, as there are very few smelting works owned by mining companies which also refine their base bullion. There is, as a rule, no great interval of time before the ore sent to these mills and smelters is reduced to gold and silver or base bullion, and, although there is some overlap at the beginning and close of the year, the tonnage shipped from the mine during the year corresponds with fair accuracy to the quantity of fine or base bullion or matte produced.

The greatest difficulties are found in the fourth item, comprising ores and concentrates shipped to custom works—generally smelters, more rarely mills—as a considerable interval of time, often thirty days or more, elapses before the ore reaches the works, and often much more before it is reduced and refined. It is mixed with other ores and loses its identity, and the assay value is the only guide the miner has to the quantity of metal produced. In these cases the miner is requested by the Geological Survey to give the tonnage and assay value of ores and concentrates shipped up to the end of the year.

It should be emphasized that the table of mine production does not give the contents of the ore mined during the year. Only the ore that is treated or sold is recorded. Neither does this report give the assay value of the total tonnage; for if this were the case the heavy losses in concentration would be disregarded, and the results would be very much larger and wholly misleading. As far as possible the report aims to give the metals recovered from the tonnage sold or treated during the year. In items 2 and 3 this is substantially correct, except for the very small refining losses. In item 4 the amount given is theoretically larger than the actual recovery of refined metals by the combined smelting and refining losses, which in the case of gold and silver are known to be very small. Practically, however, this is counterbalanced by several factors: (1) Small quantities of gold and silver are recovered from many ores, but not paid for by the smelting companies or recorded in the settlements. As a rule, payments are not made on less than 2 ounces of silver or 0.05 ounce of gold per ton. (2) Settlements are made on the basis of 95 per cent of New York price for silver and of $19 to $20 per ounce of gold. Small producers, who often report in terms of dollars alone, are very likely to give a correspondingly smaller

value than the ore actually contained. The same class of producers occasionally also misunderstand the question and report net instead of gross proceeds. (3) There is always a certain small percentage of the product which can not be obtained from the miners. This includes the output of scattered individual placer workers, often aliens; some of this is estimated on the basis of mint deposits by traders and banks, but a little invariably escapes detection. There are, further, cases where the property is not continuously operated and the owner can not be found. There is, lastly, the ore and amalgam stolen by "high graders," which takes away a notable fraction of the production of mines containing rich ore. Through small assay offices or improvised chlorination plants this gold finds its way to the mints or refining works. Gold and silver from old metallurgical by-products are also apt to escape notice. Taken together, the three items explained above will probably compensate for the losses in smelting and refining.

In general, the response from the mine owners is extremely gratifying and indicates that they realize that the individual returns are held strictly confidential, while they profit from an exact knowledge of the aggregate production and by correct reports of the state of the industry. Careful investigation has shown that willful misstatements are very rare, and, as already noted, the replies are more likely to be too low than too high. The only difficulty experienced in obtaining returns for 1908 was in Alaska, where the character and isolation of many of the mines militates against exact reports.

COMPARISON OF MINT REPORT AND MINES REPORT.

Both of the plans outlined above for the collection of statistics are admittedly open to some objections, but it may be questioned whether it would be practicable to make them wholly consistent and logical. The most important difference between the two reports is that, though covering the same time interval, they do not quite cover the same period of ore extraction, the mines report being as much as three or four months in advance of the mint report. The mill and placer bullion reaches mints and refineries soon after its production, and it does not require a long time to obtain it from the ore; but in smelting, and especially in custom work, several months may pass before the refined metals come on the market. Sampling, shipping, mixing, roasting, smelting, shipment to refinery, and refining—all these operations take time to perform.

The figures obtained by the two methods will agree, within certain limits of error, if the mining and smelting industries are carried on uniformly and at the same rate. But important disturbing factors may result in marked discrepancies between the two sets of figures, each one being a correct statement in itself. Especially is this so when abnormal conditions appear near the beginning or close of the calendar year. In time the discrepancies will balance if the reports are intrinsically correct.

In complicated statistical work small errors are unavoidable. In the mines report, according to previous explanations, the totals of gold and silver are probably slightly lower than the actual figures. In the report based on smelter and refinery reports the tendency is

probably to totals slightly higher than the actual figures, for the reason that the precious metals in ore and bullion pouring into this country from north and south lose their identity and are mingled with gold and silver from domestic sources. By painstaking effort by the establishments they are usually correctly separated, but experience has shown that in some cases no such effort has been made. It may happen, for instance, that a Mexican mining company ships bullion to a bank in Arizona. The bank may forward this bullion to a refinery where the bullion is erroneously credited to Arizona.

In 1908 the mint report has $94,560,000 in gold, while the mines report gives only $91,914,891. As shown by the data collected by the mint the refineries drew on their stock of gold of previous years to the amount of about $520,000; there were also smelter cleanings, etc., worked to the amount of at least $150,000, which is not included in the mines report; adding these two items to the latter, for purposes of comparison, the two reports stand, respectively, at $94,560,000 and $92,584,891. The Geological Survey is confident that its reports from all the States and Territories are accurate within 1 per cent, except Alaska, where the special difficulties of collecting statistics indicate a possible error of 3 per cent, or about $500,000. The year 1909 will offer an opportunity to compare the two methods by five-year periods.

In 1908 the mint report has 52,440,800 fine ounces of silver, while the mines report gives 50,878,140 ounces. In 1908 the refineries drew upon their stock of previous years to the extent of 383,000 ounces and smelter cleanings, etc., aggregated at least 150,000 ounces. Adding this to the mines report, for purposes of comparison, the two reports stand, respectively, 52,440,800 and 51,411,140 fine ounces. The principal source of difference seems to lie in the State of Colorado.

UNITS OF MEASUREMENTS.

Gold and silver are measured by the fine ounce. In the computing tables prepared by the Bureau of the Mint and the Geological Survey gold is counted as $20.671834625323 per fine ounce. The average commercial price of silver in New York in 1908 was 53 cents per fine ounce. The monthly average price of the metal fluctuated between 56 and 48.77 cents.

The standard unit for ore production is the short ton of 2,000 pounds.

PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES.

The following table gives the quantity and the value of gold and silver reported from the producing mines in 1908 to the officers of the United States Geological Survey. The last column in the table gives the increase or decrease in value as compared with the mines report of the preceding year as recorded in Mineral Resources for 1907.

Mine production of gold and silver in the United States in 1908 as reported to the United States Geological Survey, by States and Territories, in fine ounces.

State or Territory.	Gold.		Silver.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Gold, value.	Silver, quantity.
Alabama	1,993.44	$41,208	282	$150	+ $15,226	− 157
Alaska	933,290.07	19,292,818	135,672	71,906	− 56,925	− 14,112
Arizona	117,646.89	2,431,977	2,808,450	1,488,478	− 185,336	+ 296,553
California	907,590.42	18,761,559	1,647,278	873,057	+2,033,631	+ 508,420
Colorado	1,078,792.83	22,300,627	8,905,433	4,719,879	+1,474,433	−2,324,343
Georgia	2,719.01	56,207	200	106	− 8,601	− 664
Idaho	69,827.33	1,443,459	7,469,981	3,959,090	+ 187,548	− 945,450
Illinois			2,051	1,087		− 801
Massachusetts						
New Hampshire	211.30	4,368	6,270	3,323	+ 4,368	+ 6,096
Pennsylvania						
Michigan			241,055	127,759		− 58,709
Missouri			49,131	26,040		+ 23,439
Montana	147,913.34	3,057,640	10,356,199	5,488,785	− 228,572	+1,038,594
Nevada	549,682.27	$11,362,941	9,508,464	$5,039,486	− $736,514	+2,424,861
New Mexico	14,452.37	298,757	405,044	214,673	− 31,225	− 300,500
North Carolina	4,716.32	97,495	1,260	668	+ 15,302	− 20,407
Oregon	41,848.05	865,076	43,602	23,109	− 264,185	− 43,116
Philippines	11,190.97	231,338	2,350	1,246	+ 151,565	+ 2,267
Porto Rico	29.02	600	3	2	− 600	+ 3
South Carolina	2,598.46	53,715	226	120	− 1,050	+ 102
South Dakota	370,425.58	7,657,376	248,762	131,844	+3,519,187	+ 154,867
Tennessee	178.94	3,699	57,696	30,579	− 126	− 662
Texas			444,336	235,498	− 9	+ 140,648
Utah	179,054.60	3,701,387	8,451,338	4,479,209	−1,420,259	−2,538,738
Vermont					− 41	− 3,814
Virginia	118.57	2,451	236	125	− 5,837	+ 15
Washington	11,718.07	242,234	88,823	47,076	− 16,840	+ 33,464
Wyoming	385.02	7,959	3,998	2,119	− 1,385	+ 283
	4,446,382.86	91,914,891	50,878,140	26,965,414	+4,443,755	−1,621,964

Compared with the mines report of 1907, this table indicates an increase of $4,443,755 in gold and a decrease of 1,621,964 fine ounces of silver.

Twenty-three States and Territories contributed to the production of gold. The rank of the principal producers remained nearly as in 1907, and was as follows: Colorado, Alaska, California, Nevada, South Dakota, Utah, Montana, Arizona, and Idaho. The only difference consists in an exchange of places between Utah and Montana. None of the other States reached an output of $1,000,000.

Twenty-eight States and Territories participated in the production of silver. The rank of the principal producers was as follows: Montana, Nevada, Colorado, Utah, Idaho, Arizona, and California. Colorado has lost the first place to Montana, and has fallen below Nevada also.

MINE PRODUCTION BY STATES AND TERRITORIES.

Alaska.—The gold production of Alaska in 1908 amounted to $19,292,818, and was less than that of 1907 by $56,925. Though the total gold production was about the same in the two years, there was in fact a large decrease in the placer production of 1908, which was compensated for by a corresponding increase in the output of the aurifer-

ous lodes. The production was divided approximately as follows: From the Pacific coast belt, $3,448,380; from the Copper River and Cook Inlet region, $401,500; from the Yukon basin, $10,323,000; from the Seward Peninsula, $5,120,000. The copper mines of Prince of Wales Island and Prince William Sound, in the coast region, contributed $47,483 in gold. The production in the Fairbanks district was approximately $9,200,000, about 300 mining plants being in operation; this was an increase of $1,200,000 compared with the output of 1907. The placers of the Seward Peninsula, chiefly near Nome, yielded only $5,100,000, a decrease of $1,900,000 from the figures for 1907. A dry season and the exhaustion of the mines of the third beach line were the reasons for the decline. The total production of placer gold in Alaska was about $15,900,000.

The production of silver was, as usual, small, amounting to 135,672 ounces, a decrease of 14,112 ounces. Most of it was derived from the small percentage of this metal which is contained in placer gold. The copper ores of the Pacific coast belt yielded 33,602 ounces of silver.

Arizona.—The gold production of Arizona amounted to $2,431,977, a decrease of $185,336 compared with that of 1907. As usual, Yavapai, Cochise, Yuma, and Mohave are the principal producing counties, in the order indicated. Yavapai County yielded $1,116,793, but none of the others attained a production of $1,000,000; Mohave County yielded $295,736. None of the counties not enumerated above reached a production of $60,000 in gold. Compared with the output of 1907, that of Yavapai was slightly reduced; Mohave County decreased its output greatly, owing to the idleness of the Gold Road mill; considerable increases are reported for Cochise and Yuma counties, in the former due to greater activity in copper mining at Bisbee, in the latter to increased activity in the Kofa district. In Yavapai County the yield from copper ores decreased, while a corresponding increase was noted in the product of the siliceous ores. Over $1,500,000 of the gold from Arizona was recovered from siliceous ores and about $861,000 from copper ores. From placer mining was recovered $30,937 in gold, somewhat less than in 1907.

Silver was produced in Arizona to the amount of 2,808,450 fine ounces, an increase of 296,553 ounces as compared with the output of 1907. Cochise County, which contains the great copper mines of Bisbee and the silver-lead-gold mines of Tombstone, led in the production of silver, having yielded 1,630,749 fine ounces in 1908. Yavapai County was next in rank, with 602,645 ounces. Gila, Graham, and Pima counties yielded smaller outputs, and the minor quantities came from Mohave, Santa Cruz, Pinal, and Maricopa. The principal producers of silver in Arizona, each of them yielding over 300,000 ounces, were the Tombstone Consolidated, the United Verde, the Copper Queen, and the Commonwealth mines. The silver obtained from copper ores was 1,777,266 ounces, while siliceous ores yielded 899,072 ounces.

California.—The output of gold in California in 1908 was $18,761,559, an increase of $2,033,631 as compared with 1907, and almost exactly the same amount as the product of 1906. The rank of the most important counties was as follows: Butte yielded $3,139,398, a considerable increase for 1908. The gold was almost exclusively derived from the constantly extending dredging operations at Oroville; Nevada County yielded the increased amount of $2,297,963,

chiefly from the quartz mines at Grass Valley and Nevada City; Yuba County produced $2,034,486, almost all of which came from dredging operations; Amador County, $1,876,174; Calaveras County, $1,378,511; Eldorado, Tuolumne, and Mariposa together, $1,580,647; the latter five divisions are generally known as the Mother Lode counties, and the product is mainly derived from gold quartz mines. Shasta County produced $1,131,832 from mixed sources. The siliceous gold ores of the State yielded $10,050,853, the copper ores $473,092, both figures showing a fair increase. The placer gold amounted to $8,231,187; the increase of about $1,400,000 over the corresponding figures for 1907 was due to still greater activity in dredging operations, which in 1908 yielded $6,536,189.

The production of silver was 1,647,278 ounces, an increase of 508,420 ounces for 1908 as compared with 1907. The larger part of this output, 909,947 ounces, was derived from the copper ores of Shasta County and was obtained during the electrolytic refining of the blister copper. Calaveras County produced 107,657 ounces from the same kind of ores. Kern County added 181,657 ounces from siliceous ores. The remainder came mainly as a by-product from placer and gold quartz mines. A small output of pure silver ores is still mined in San Bernardino County.

Colorado.—Colorado produced $22,300,627 in gold in 1908, an increase of $1,474,433 as compared with the yield of 1907. Although the silver and lead mining industry suffered severely from the financial conditions and the decline in metal prices which followed the monetary disturbances of 1907, the gold-mining industry was not similarly affected. On the contrary, it was stimulated by the great extension of leasing and prospecting operations in the gold-mining camps. This applied particularly to Cripple Creek, which furnishes over one-half of the gold production of the State. Better milling facilities were also available, and progress was made in the treatment of low-grade ores. The gold production of Cripple Creek, equivalent to that of Teller County, was increased in 1908 by $1,826,600 to a total of $12,740,287, and the tonnage was increased by 150,091 tons to a total of 601,173. The average value of the ore in gold was, however, reduced from $24.28 per ton in 1907 to $20.51 per ton in 1908. The rates of transportation are now lowered, so that an ore containing only $8 per ton might be shipped with some profit.

The counties ranking after Teller in yield of gold were San Miguel, Ouray, Lake, and Gilpin, in the order named. The two first named produced over $2,000,000 each, and Lake and Gilpin over $1,000,000 each. San Juan County came very near to the last-mentioned figure. Clear Creek County yielded over $600,000, and Park County over $400,000. The "San Juan country," including San Miguel, Ouray, San Juan, Dolores, Hinsdale, Montezuma, and La Plata counties, produced $5,486,823, against $6,270,216 in 1907. The three counties of Gilpin, Clear Creek, and Boulder produced together $1,882,158, against $1,623,042 in 1907. The two principal sources of the increase in the gold production of Colorado were thus the Cripple Creek district and the Clear Creek mining region. In contrast to a greatly decreased silver yield, Lake County (Leadville) increased its gold production somewhat. Siliceous or dry ores furnished 82 per cent of the tonnage mined in the State, and yielded $21,051,280, or 94 per cent of the production. A little over 2 per cent came from

copper-lead ores, and less than 2 per cent from lead ores. The production of placer gold increased to $184,935 from $100,830 in 1907. The large additions from this source in the last few years have been mainly caused by dredging operations at Breckenridge, in Summit County.

Colorado produced only 8,905,433 ounces of silver, a decrease of 2,324,343 ounces as compared with the yield of 1907. In 1904 nearly 14,000,000 ounces were produced; the silver production of Colorado has declined since then by about 5,000,000 ounces. Almost every county in the State decreased its yield of silver. The smelting ores of Lake County (Leadville) led, as usual, in the output of silver, but yielded only about 2,900,000 ounces, against approximately 4,200,000 ounces in 1907. San Miguel came next for 1908, instead of Pitkin, and its production was somewhat over 1,500,000 ounces, a moderate increase over the yield for 1907. Pitkin and San Juan counties each produced about 1,000,000 ounces, in both cases a considerable decrease compared with the output of 1907. The yields from Mineral and Clear Creek counties were, respectively, 726,000 and 504,000 ounces, a moderate decrease in both cases. The three districts of Leadville, Aspen, and Creede, which mainly produce smelting ores, yielded 4,660,798 ounces, against 6,744,815 in 1907. The "San Juan country" produced 3,228,150 ounces, almost the same quantity as in 1907. The Clear Creek counties reported 712,079 ounces, against 751,191 in 1907. Ores classed as siliceous or dry gave 5,553,591 ounces, or 62 per cent of the silver output; copper-lead ores yielded 941,394 ounces, or 11 per cent; lead ores produced 1,501,803 ounces, or about 17 per cent.

Idaho.—The mines of Idaho yielded $1,443,459 in gold, an increase of $187,543. One-third of this product, or $389,915, came from the siliceous ores of the Carson district, in Owyhee County, and chiefly from the De Lamar and the Trade Dollar mines. Custer County came next in 1908, with $282,562, instead of Boise, which usually ranks second in gold production. More than half of this output came from copper ores. Boise County had an output of $199,307, as usual chiefly from placers. Idaho County increased its production to $192,934, mainly from the milling ores of Elk City. Elmore County yielded $152,621, also an increase, and due to active operations on milling ore at Atlanta. The placer production of the State was $285,643, a decrease of about $68,000. Dredging operations contributed $77,189, or about the same as in 1907.

Of silver, 7,469,981 ounces were produced, a decrease of 945,450 ounces as compared with the output of 1907 and of over 1,500,000 ounces as compared with that of 1906. Of this total, 5,756,527 ounces came from the lead ores of the Coeur d'Alene district, a decrease of about 850,000 ounces as compared with 1907. From copper ores in the same district were derived 607,553 ounces. The lead ores of the Wood River district contributed 125,463 ounces, and the siliceous silver-gold ores of Owyhee County, where the De Lamar and the Trade Dollar are the principal mines, added 857,537 ounces.

Michigan.—The copper mines of Michigan yielded 241,055 ounces of silver, a decrease of 58,709, as compared with the output of 1907. This silver was produced by 6 companies and chiefly by electrolytic refining of certain grades of copper. The copper thus refined came from 1,494,333 tons of copper ore, and it yielded 237,460 ounces of

silver or 0.1589 ounces per ton of ore. Only 3,595 ounces of silver came from "pickings" or metallic lumps saved in the stamp batteries from the concentration of 561,866 tons of ore. The whole silver production was derived from amygdaloid ores.

Missouri.—A small quantity of silver is annually recovered from the lead of southeast Missouri. The silver content is only from 1 ounce to 1¾ ounces per ton of lead. In 1908 there were 49,131 ounces obtained, against 25,692 ounces in 1907.

Montana.—The gold production of Montana in 1908 amounted to $3,057,640, a decrease of $228,572, as compared with the output of 1907. Most of the counties showed slightly lessened output, except Fergus, Beaverhead, and Broadwater counties. No single county produced $1,000,000, the greatest production, $761,096, being reported from Fergus County, chiefly from siliceous milling ores, and the next production being from Silverbow County, $661,619, chiefly from copper ores. Madison County contributed $172,643 from deep mines and $414,939 from placer operations. Chouteau County yielded $264,910, mainly from the milling ores of the districts in the Little Rocky Mountains. Jefferson, Broadwater, and Lewis and Clark counties yielded gold mainly from smelting ores of various kinds, the amounts varying from $137,000 to $220,000. The placer gold of the State amounted to $549,995, an increase of $201,328 over 1907; most of this came from dredging operations in Madison County.

The yield of silver was 10,356,199 fine ounces, an increase of 1,038,594 ounces, as compared with 1907. This increase is almost wholly due to a larger production of silver-bearing copper in Silverbow County. In 1908 the silver from that county was 8,500,729 ounces. Jefferson County added 1,047,157 ounces, chiefly from smelting ores in the Elkhorn, Cataract, and Colorado districts. The output of Granite County, 450,068 ounces, does not materially differ from that of 1907, and was mainly produced from smelting ores. Lewis and Clark County produced 108,121 ounces from smelting ores. None of the other counties attained a production of 100,000 ounces.

Nevada.—The mines of Nevada yielded $11,362,941 in gold, a decrease of $736,514, as compared with the production of 1907. As usual, the larger part of this output was derived from siliceous gold and gold-silver ores from the Goldfield, Tonopah, and other districts in Esmeralda and Nye counties. Esmeralda County produced $5,985,070, of which Goldfield yielded $4,880,251, nearly 43 per cent of the total gold production of the State. The remainder was divided among many camps. After many years of preparation, the Silver Peak mines have begun production on a large scale. Rawhide district yielded $125,475 in gold. Nye County produced $3,074,586 in gold, of which $1,624,491 came from the Tonopah district, $645,457 from Bullfrog, and the remainder from Round Mountain and Manhattan districts. The output of Lincoln County, in which the De Lamar district is of first importance, was $518,306 in 1907. The Comstock, considered equivalent to Storey County in production, yielded $599,670, more than doubling the output of 1907. The new county of Clark produced $280,166 in gold, Searchlight being the most important district. Humboldt County greatly increased its production, which was $273,227, mainly from operation in the Chafey and Seven Troughs districts. Elko County yielded $184,419, Eureka County $172,396.

The lead and copper ores contributed about $235,000 to the gold production of the State. The placers yielded $79,751, a considerably larger amount than that recovered in 1907. The larger part came from the gravel deposits of Round Mountain and Manhattan in Nye County.

The output of silver was 9,508,464 ounces, or 2,424,861 ounces more than the product of 1907. Nye County was, as usual, of paramount importance, having produced 7,632,813 ounces, of which all but 460,417 ounces came from Tonopah. The Comstock mines in Storey County yielded a greatly increased output of 542,017 ounces. Esmeralda County produced 438,588 ounces, of which one-half came from the new Lucky Boy district. Almost the entire production was from siliceous ores. The lead ores yielded 482,018 ounces, mainly from Esmeralda and Eureka counties. From copper ores only 29,321 ounces were obtained.

New Hampshire.—A small production of gold and silver was recovered from the copper ores of New Hampshire, and minor amounts derived from ores from Massachusetts and Pennsylvania have been included in the New Hampshire figures.

New Mexico.—The gold produced in the mines of New Mexico was valued at $298,757, a decrease of $31,225. Owing to the closing of the Comanche smelter, the mines of Grant County only produced $45,682 in gold, mainly from smelting ores. Socorro is now the leading gold-producing county, its output having the value of $136,890, chiefly from the siliceous ores of the Mogollon district. No other county attained a production of $40,000. Otero increased its output to $35,690, this being due to the operation of the new smelter at Oro Grande. Lincoln County reported $29,712, which was somewhat less than the output of 1907. The placers yielded nearly $30,000.

The production of silver amounted to 405,044 ounces, a decrease of 300,500 ounces. Socorro and Grant remained the leading counties, with a production of 280,091 and 95,477 ounces, respectively. The production in the other counties was insignificant. Practically the whole output of Socorro County was derived from the siliceous milling ores of the Mogollon district. Only 10 per cent of the silver production of New Mexico is obtained from copper and lead ores.

Oregon.—The production of gold in Oregon amounted to $865,076, a decrease of $264,185. Both deep mines and placers showed a material decrease in yield. Baker County led with an output of $507,929, most of which came from the siliceous ores of the Cracker Creek district, near Sumpter. Josephine County produced $152,722, of which the larger part came from placers.

The total yield of the placers was $272,593, a decrease of $58,813. Only an insignificant amount of gold was derived from copper ores. Southwestern and northeastern Oregon form two distinct mining regions, differing in character of deposits and ores. The southwestern region, of which Josephine and Jackson counties are the principal parts, produced $250,664 in gold, a reduction of $145,834 from the output of 1907. The placer gold from this region in 1908 amounted to $193,484. The northeastern region, of which Baker and Grant counties are the most important parts, yielded $614,432. The placer gold from this region was $79,109 in 1908.

The yield of silver was only 43,602 ounces, a decrease of 43,116 ounces as compared with that of 1907. To this Baker County con-

tributed 17,495 ounces and Grant County 17,987 ounces, both counties being situated in the northeastern part of the State.

Southern Appalachian States.—Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia yielded together $254,775 in gold, an increase of $14,873 over the output of 1907. A considerable increase was reported from Alabama and North Carolina, while the other States reduced their production. The greatest output, $97,495, came from North Carolina; this was followed by Georgia, with $56,207; South Carolina, with $53,715; and Alabama, with $41,208. Tennessee yielded only $3,699. As usual, siliceous ores yielded the greatest amount, principally from the Iola mines, in North Carolina; the Haile mine, in South Carolina; the Franklin mine, in Georgia; and the Hillabee mine, in Alabama. The total output of placer gold was about $31,000.

Of silver 59,900 ounces were produced, a decrease of 24,674 ounces. The lessened production was mainly due to a decreased production of copper ores in North Carolina and Virginia. The only States which had a notable output of silver were Tennessee, with 57,696 ounces, and North Carolina, with 1,260 ounces. The production of North Carolina in 1907 was 21,667 ounces. Almost the whole output was derived from copper ores.

South Dakota.—South Dakota produced $7,657,376 in gold, an increase of $3,519,187 compared with the yield of 1907. After the misfortunes of 1907 the Homestake mine greatly increased its production and all of the principal districts of the Black Hills had a prosperous year. The silver production was 248,762 ounces.

Texas.—Texas produced only a nominal amount of gold. The yield of silver was 444,336 ounces, an increase of 140,648 ounces as compared with that of 1907. The metal was largely derived from the siliceous oxidized ores of the Shafter mine, in Presidio County.

Utah.—The mines of Utah yielded $3,701,387 in gold, a decrease of $1,420,259 as compared with the output of 1907. The decrease was general, affecting all the producing counties. As usual the Tintic and the Bingham districts, which nearly correspond to Juab and Salt Lake counties, were the most prominent producers of gold from smelting ores, which yielded, besides, silver, copper, and lead. The Tintic ores contributed $1,307,464; those of Bingham yielded $1,248,221, the figures in each case representing a greatly lessened yield compared with the output of 1907. The cyaniding ores of the Mercur district added $861,891. These three districts yielded 92 per cent of the gold production of the State. A small amount of placer gold was derived from the southern part of the State.

Of silver 8,451,338 ounces were reported, a decrease of 2,538,738 ounces as compared with the figures of 1907. This greatly lessened yield reduced Utah to the fourth instead of the second rank among the silver-producing States, its production being exceeded by that of Montana, Nevada, and Colorado. The bulk of the silver was derived from the lead-copper ores of Tintic, which yielded 4,118,440 ounces, or nearly one-half of the total; further, from the mixed ores of Bingham, which yielded 1,053,146 ounces; and from the lead ores of Park City, which produced 2,463,735 ounces. The combined silver production of these three districts was 7,635,321 ounces. The

greatest decrease was recorded for the Tintic district, but the yield from Park City and Bingham mines was also greatly lessened.

Washington.—From the mines of Washington a gold production of $242,234 was reported in 1908, a decrease of $16,840 as compared with 1907. The largest portion of this output came from the Pierre Lake district, in Stevens County. There was little activity in the Republic and the Mount Baker and the Monte Cristo districts. Stevens County produced $183,894 in gold, followed by Ferry County with an output of $17,333. Only a small amount of gold was derived from lead and copper ores. The placers yielded only $19,478.

The output of silver was only 88,823 ounces, most of which was derived from siliceous ores and copper ores of Stevens County, and from siliceous ores of Okanogan County.

Wyoming.—The production of gold from Wyoming amounted to $7,959, a decrease of $1,385 as compared with 1907. Most of this gold was derived from copper ores of the Encampment district, but the mines were not continuously operated. The development of the new Copper Mountain district, in Fremont County, may increase the future production of the State.

The production of silver was insignificant; it amounted to 3,998 ounces in 1908.

Philippine Islands.—The total production of gold in the Philippine Islands in 1908 was valued at $231,338, and the production of silver was 2,350 fine ounces.[a]

As the gold production for 1907 was only $79,773, the production in 1908 was apparently trebled. The actual increase was below this, however, as some of the gold credited to 1908 was actually produced in 1907 but not accounted for in the Survey figures for that year.

The production of Mountain Province in 1908 was $139,328 in gold, as compared with $80,372 in 1907; that of Camarines Province was $71,731 in gold, as against $2,067 in gold in 1907; that of Sorsogon Province (Masbate) was only $620 in gold, as compared with $11,411 in gold in 1907; and the output of Surigao Province was $5,581 in gold, against nothing reported for 1907.

Gold is found in many islands of the group, but production was reported but from Luzon, Masbate, and Mindanao in 1908, and but from Luzon and Masbate in 1907. The producing provinces in 1908 were Mountain Province, in the northern part of Luzon, embracing the former provinces of Benguet (which furnishes the greater part of the gold), Lepanto, and Bontoc; Ambos Camarines, on the east coast of Luzon; Sorsogon, of which the island of Masbate is a part; and Surigao, in the northeastern part of Mindanao. In all of these but Sorsogon there is a considerable annual placer production by natives. The production mainly reaches small traders, mostly Chinese, and much of the gold goes to China. The average fineness of placer gold in the Philippines is not more than 0.850. In underground mining in a limited way, also, the Igorots of Mountain Province have long been adept.

The greatly increased production of the Philippines was due, however, to preparatory work of several years on the part of Americans, Europeans, and New Zealanders.

[a] For information relating to the production of the Philippines, the United States Geological Survey acknowledges cooperation with the Division of Mines, Bureau of Science, Manila, Philippine Islands, to which direct returns are made from the mines, and which has published the results in reports for 1907 and 1908 entitled: "The mineral resources of the Philippine Islands."

Prospectors were early encouraged by their discoveries, but greatly hindered by many obstacles; only in 1908 have some tangible results finally appeared. Conditions at the close of 1908 were highly encouraging for a continued increase of production.

In Mountain Province, the Mancayan copper mines, in Lepanto, have remained idle, owing to failure of American capital to secure satisfactory terms for purchase.

At Suyuc, near the Lepanto-Benguet line in Mountain Province, gold occurs both free and with pyrite in narrow veins in diorite, and there is a small annual production, chiefly by natives. The main production of gold in the Philippines and the large increase noted in this province was from Antamok district, near Baguio, in the central part of Benguet. Here the Bua Mining Company and the Benguet Consolidated Mining Company have each done considerable development in pyritic gold-quartz ores, partially oxidized, found in veins in basal diorite and later andesites. Each of these companies operated a 6-stamp Hendy mill with cyanide plants, and made an important production in 1908. Below the Bua mine, on the Antamok, is the Camote mine, which has yielded gold from oxidized siliceous ore. Near Baguio, from underground and surface workings in partially decomposed andesites, there is a considerable yearly production of gold by Igorots. On Gold Creek development work has been done on the Naptung and other quartz veins carrying free gold, gold tellurides, and pyrite. Similar work was done on the Copper King mine and the claims of the Headwaters Mining Company also near Baguio.

In the Province of Ambos Camarines the production was from the Paracale district on the east coast of Luzon, and in 1908 was all of placer gold. There was a large increase, already noted, over the output of 1907. The chief producer was the Paracale Dredging Company, operating a dredge of the New Zealand type on Paracale River near the town. In the last six months of 1908 a little more than 50,000 cubic yards of gravel were handled by the dredge, according to the company reports, from which was recovered slightly over $1 in gold per cubic yard. The dredge yields free gold caught in the tables, gold in black sand concentrates stored or shipped to smelters, and gold in pebbles and broken vein material which is reserved for future milling. The operations of the first dredge have been so promising that another of the same type was in course of construction, and an American dredge from Masbate was transferred to Paracale at the close of 1908. In addition to dredging, a considerable amount of placer gold is annually recovered by natives. The quartz mines of the district in metamorphic and igneous rocks made no production in 1908, but development work was done on the San Mauricio and Tumbaga mines recently acquired by American interests.

In Sorsogon Province the only producing district was at Aroroy in the northern part of the island of Masbate, where free gold is found in the upper parts of quartz veins in igneous rocks; below water level the gold is mostly in pyrite.

There have been repeated attempts to work the gravels of Guinobatan and Lanang rivers by dredging; but the Lanang dredge was wrecked in 1908, and the results on the Guinobatan have been discouraging and the dredge has been transferred to the Paracale district. The production of Aroroy district was less in 1908 than it

1907. The operators are chiefly doing development work. The three small stamp mills in the district were idle.

In Surigao Province, in northeastern Mindanao, there has been considerable mining in a small way of auriferous quartz stringers in andesite, and in gravel and decomposed rock in place near the contact of andesite and chlorite schist. The gravel is worked both by ground sluicing and by panning, and as some of it yields over $1.30 in gold per cubic yard natives have made a fair living by working it. This district has had a small but steady output of gold, particularly from placer mines, for many years; but figures of production were not available until 1908.

NUMBER OF MINES, ORE PRODUCTION, AND AVERAGE VALUES.

The following table indicates the number of producing mines in 1908, divided into placer mines and deep mines. In the former mines values, generally in gold, are extracted from gravels or sands; the "deep mines" work deposits in solid rock which have not been disintegrated and sorted by erosion. The total number of mines is of course much larger than the figures given, because many properties for various reasons are idle or are being developed without having yet attained a producing stage.

It is perhaps a little difficult, especially in the case of placers, to define what constitutes a mine. In some places a fairly large aggregate output is obtained, usually through traders and storekeepers, from transient or intermittent work of wandering miners which can not be credited to separate properties.

Number of producing mines in 1908 by States and Territories.[a]

State or Territory.	Number of mines.			State or Territory.	Number of mines.		
	Placer.	Deep.	Total.		Placer.	Deep.	Total.
Alabama and Georgia	25	14	39	New Mexico	26	108	134
Alaska	1,270	20	1,290	North Carolina	26	16	42
Arizona	31	279	310	Oregon	173	66	239
California	559	495	1,054	South Carolina	2	5	7
Colorado	43	624	667	South Dakota	8	19	27
Idaho	207	178	385	Tennessee	1	4	5
Michigan	.....	6	6	Texas	.....	5	5
Missouri	.....	4	4	Utah	6	170	176
Massachusetts				Virginia	4	4	8
New Hampshire	.....	3	3	Washington	27	37	64
Pennsylvania				Wyoming	6	5	11
Montana	157	409	566				
Nevada	28	393	421	Total	2,599	2,864	5,463

[a] Illinois, Philippines, and Porto Rico not included.

The table shows the number of gold and silver producing mines in the United States. In the States of the Rocky Mountain region and the Pacific slope practically every mine producing lead, copper, or zinc also yields the precious metals. The table, therefore, actually records the number of producers of gold, silver, copper, lead, and zinc in these Cordilleran States. It also records the gold and silver producing mines in Michigan and in the Eastern States. It has not been possible to trace the production of Illinois to individual mines.

Compared with the corresponding table for 1907 notable additions are found. The placer mines operated in 1908 are 2,599 in number,

against 2,586 in 1907. The deep mines number 2,864 in 1908, against 2,604 in 1907. In Alaska it has proved difficult to record all the small operations, and the number of placer mines is therefore, in part, an estimate.

There are no great changes in the number and distribution of placer mines. The number of deep mines or lode mines has increased considerably during the last three years from 2,114 in 1906 to 2,864 in 1908. The number of producing deep mines decreased in 1908 in Arizona, South Dakota, Wyoming, and Michigan; the change in Michigan was, however, simply due to the tracing of the silver product to a limited number of mines. Notable increases in the number of producing lode mines are recorded from Colorado, Idaho, Montana, Nevada, and Utah. In Nevada the deep mines increased from 216 in 1907 to 393 in 1908.

The best guide to the development of deep mines is, however, found in the record of tonnage of ores mined, which is given in a subsequent table.

A proper classification of the western ores is very difficult on account of their complex nature and the transitions between the various classes, however they may be defined. The classification in the following table is based on the quality of the ore as mined. The ores are divided into dry or siliceous ores, which comprise the gold and silver ores proper; further into copper ores, lead ores, zinc ores, copper-lead-zinc ores, and lead-zinc ores. It is not possible to divide the dry or siliceous ores into gold ores and silver ores, for the two metals are present in them in all proportions. However, the silver ores mined exclusively for silver form a very small class and less than 100,000 tons of them were mined. Under copper ores are classed those which contain 2½ per cent or more of copper, as well as those which contain less than this amount, provided their principal value is in copper. The Lake Superior ores contain, for instance, only from 1 to 2 per cent of copper, and from the Bingham porphyry ores less than 1.5 per cent is recovered. The lead ores are those which contain over 4½ per cent of lead, irrespective of their tenor in precious metals. Special divisions of mixed ores have been established. A comparatively small amount of zinc is mined as zinc ores, and these contain at least 25 per cent of that metal. Most of the argentiferous zinc ores of the Rocky Mountain States are mined as lead-zinc ores and are subsequently concentrated.

Ore production in short tons and average extraction value of gold and silver per ton in 1908, by States and Territories.[a]

State or Territory.	Dry or siliceous ores.		Copper ores.		Lead ores.		Zinc ores.		Copper-lead and copper-lead-zinc ores.		Lead-zinc ores.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.
Alabama, Georgia	17,370	$4.92											17,370
Alaska	1,477,436	2.28	51,509	$1.26									1,528,945
Arizona	375,500	5.32	3,315,140	.54	5,519	$15.64	695	$2.94	84	$23.50			3,696,938
California	2,025,594	5.09	513,414	1.99	7,532	5.05			368	2.35			2,546,908
Colorado	1,830,930	13.10	12,347	16.67	100,861	11.58	2,583		58,236	16.94	238,934	$2.01	2,243,891
Idaho	125,657	11.34	107,400	4.68	1,456,096	2.19	63		15	32.68			1,689,231
Michigan			2,056,205	.06									2,056,205
Massachusetts, New Hampshire, and Pennsylvania			3,710	1.88									3,710
Missouri					441,190	.05							441,190
Montana	390,442	6.85	3,828,876	1.32	18,274	11.34	28,133	1.49	297	47.84			4,266,022
Nevada	951,880	16.58	434,887	.26	34,755	11.56	1,793		2,217	10.05			1,425,532
New Mexico	31,642	12.34	93,359	.97	3,859	2.18	6,554		20	26.38			135,434
North Carolina	9,070	8.88	18										9,088
Oregon	48,551	12.50	2,133	20.78									50,684
South Carolina	16,776	3.15	19	7.53									16,795
South Dakota	1,929,513	4.03			36	58.72							1,929,549
Tennessee			618,806	.026			19,227						638,033
Texas	21,473	10.74	139		132	36.83	79						21,823
Utah	352,274	3.03	2,976,433	1.24	321,417	10.47	99	5.86	6,734	7.05	2,000	2.65	3,658,957
Virginia	230	7.14	1,896	.05	800	.28	9,951						12,877
Washington	29,596	8.57	6,478	1.85	1,559	3.24							37,633
Wyoming	5	82.60	19,026	46									19,031
	9,633,939	7.28	14,041,795	.91	2,392,030	3.55	69,177	.64	67,971	15.82	240,934	2.01	26,445,846

[a] Illinois, Kentucky, Philippines, and Porto Rico not included in this table.

In all, 26,445,846 short tons of ore containing gold and silver were mined and sent to reduction works in 1908. This can not be directly compared with the corresponding total for 1907, because that included the whole tonnage from Michigan, or nearly 10,000,000 tons, whereas it has been found possible in 1908 to trace the relatively small silver production of that State to about 2,000,000 tons of copper ores. Taking these changes into consideration the ore production of 1907 was 23,788,934, and that of 1908, therefore, shows an increase of 2,656,912 tons.

The division of the tonnage shows that the siliceous or dry and the copper ores are by far of most importance with, respectively, 9,633,939 and 14,041,795 tons, against 8,080,601 and 12,198,675 tons in 1907. The quantity of lead ores containing gold and silver was 2,392,030 tons, a decrease of about 400,000 tons compared with the tonnage of 1907. The tonnage of zinc ores increased somewhat, to 69,177 tons, but the lead-zinc ores decreased heavily, from 1,048,592 tons in 1907 to 240,934 tons in 1908.

The tonnage of siliceous ores increased notably in all States except Oregon, New Mexico, and South Carolina. Nevada made the most striking gain, from 628,501 tons in 1907 to 951,880 tons in 1908. Alaska, California, and South Dakota also made great increases.

General gains are also shown in copper ores, especially in Utah, which gained over 1,000,000 tons, and in Nevada, Arizona, and California. Less copper ores than in 1907 were mined in Alaska, Colorado, Idaho, and New Mexico. The larger tonnage was mainly due to the beginning of the mining on a great scale of the so-called "porphyry ores" of Utah and Nevada. Lead ores (including a small amount of copper-lead ores) were mined mainly in Idaho, Colorado, and Utah; but while the great tonnage in Idaho, chiefly from the Coeur d'Alene mines, increased considerably, the output of Colorado and that of Utah was reduced to almost one-half of that of 1907.

The tonnage of lead-zinc ores of Colorado declined heavily in 1908, and only minor amounts were shipped from other States.

The greatest average extracted values in gold and silver are found in the class of the siliceous ores, but they declined to $7.28 per ton in 1908 from $8.27 per ton in 1907. The figures indicate $16.58 for Nevada, against $25 in 1907; $11.34 for Idaho, against $13.60 in 1907; $5.32 for Arizona, against $6.47 in 1907; $5.09 for California, against $5.75 in 1907; $2.28 for Alaska, against $2.30 in 1907; $3.03 for Utah, against $3.36 in 1907. The tendency to lower average values is manifest.

The copper ores were very much poorer in gold and silver; the highest average values of $16.67 and $4.68 per ton are found, respectively, in Colorado and Idaho. In the copper-producing States proper the values per ton were very much lower; Utah, $1.24, against $3.09 in 1907; Montana, $1.32, against $1.43 in 1907; and Arizona $0.54, against $0.56 in 1907.

The lead ores averaged $3.55 per ton in gold and silver, against $5.81 in 1907. In Colorado their average precious metal value was $11.58, against $7.72 in 1907; in Utah $10.47, against $10.02 in 1907; in these States a smaller tonnage of richer ores was mined. The lead-zinc ores, chiefly from Colorado, average $2.01 per ton in gold and silver.

DISTRIBUTION OF THE GOLD PRODUCT OF 1908.

The following table shows the source of gold in the United States in 1908, by kinds of ore and by States:

Source of gold in 1908 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama	45.72	1,947.72						1,993.44
Alaska	768,582.00	162,411.08	2,296.99					933,290.07
Arizona	1,496.58	73,523.55	41,640.36	864.84	80.00	41.56		117,646.89
California	398,183.66	486,210.01	22,885.83	310.91				907,590.42
Colorado	8,946.23	1,018,355.67	5,006.03	17,973.93		23,597.39	4,913.59	1,078,792.83
Georgia	541.85	2,177.16						2,719.01
Idaho	13,817.97	,45,417.29	8,152.32	2,439.24		.51		69,827.33
Massachusetts, New Hampshire, and Pennsylvania			211.30					211.30
Montana	26,606.01	85,473.31	32,365.34	2,303.44	1,112.23	53.01		147,913.34
Nevada	3,857.96	534,050.81	4,629.58	7,129.35		14.57		549,682.27
New Mexico	1,122.20	9,544.82	3,757.09	26.27		1.99		14,452.37
North Carolina	849.23	3,867.09						4,716.32
Oregon	13,186.68	28,377.64	283.73					41,848.05
South Carolina	39.18	2,556.28	3.00					2,598.46
South Dakota	480.95	369,932.10		12.53				370,425.58
Tennessee	29.61		149.33					178.94
Utah	440.69	47,439.15	111,086.12	19,986.36	1.35	90.17	10.76	179,054.60
Virginia	31.98	78.85		7.74				118.57
Washington	942.24	10,737.33	36.13	2.37				11,718.07
Wyoming	39.67	19.98	325.37					385.02
Total	1,239,240.41	2,882,119.84	232,828.52	51,056.98	1,193.58	23,799.20	4,924.35	4,435,162.88
Value	$25,617,373	$59,578,704	$4,812,993	$1,055,441	$24,674	$491,973	$101,795	

[a] Illinois, Philippines, and Porto Rico not included.

General statement.—The totals in this table indicate that the placer gold made 28 per cent of the whole production, and that gold from siliceous ores amounted to 65 per cent. Copper ores yielded only 5 per cent, lead ores 1 per cent, and mixed ores 1 per cent, a total for the base-metal ores of only 7 per cent, in spite of an exceedingly heavy tonnage of these ores. This shows that it is futile to look for a heavily increased production of gold from an increase in the activity of base-metal mining.

Compared with the yield of 1907, the placer gold increased by about $959,000; the gold from siliceous ores increased by the considerable amount of $5,300,000; the gold from lead ores decreased heavily to less than half of the quantity obtained in 1907; and the gold from mixed ores remained about the same figures.

Placers.—The placer gold amounted to $25,617,373 in 1908, against $24,659,230 in 1907. The greatest production in recent years was attained in 1906, when nearly $27,500,000 was recorded. As usual of late years, Alaska led, with about $15,900,000, a small decrease from the production of 1907. California yielded $8,231,187, and here we find the principal source of the increase of the total. In each of the other States the placer production was on a much smaller scale. Oregon and Idaho reduced their output materially, in large part on account of unfavorable seasons. On the other hand, dredging operations in Montana and Colorado greatly increased the placer yield of these States.

Gold dredging has developed into a most important industry in California. The yield from this branch of mining in that State in recent years has been as follows: 1904, $2,187,038; 1905, $3,276,143; 1906, $5,098,359; 1907, $5,065,437; 1908, $6,536,189. Sixty-nine dredge boats were operating in California in 1908. The total yield from all dredging operations outside of California was only $815,584 in gold, divided between Alaska, Colorado, Georgia, Idaho, Montana, and Oregon. The corresponding output for 1907 was $571,659. Details can not be given without disclosing the production of single operators. Nineteen dredge boats were in operation as follows: Alaska, 4; Colorado, 4; Georgia, 1; Idaho, 5; Montana, 4; and Oregon, 1. No gold was reported from dredging along Snake River.

Drift mining in frozen ground has yielded most of the gold from the Lower Tanana, in Alaska, and a large part of the gold from the Seward Peninsula is also obtained by this method of mining. In California drift mining still remains an important branch, but the yield is declining, and was only about $390,545 in 1908.

The remaining placer gold is won by the hydraulic method or by surface sluicing work, which is practiced in all of the placer States. A very small amount of placer gold is derived from dry washing in New Mexico and Arizona.

Dry and siliceous ores.—The production of gold from dry and siliceous ores in 1908 amounted to $59,578,704, against $54,274,876 in 1907. The States which yielded over $2,000,000 from this source rank as follows: Colorado, Nevada, California, South Dakota, and Alaska. Compared with the preceding year, California, Alaska, Idaho, South Dakota, and Utah showed considerable gains, while less amount of gold was recovered from this source in Nevada, Montana, New Mexico, and Oregon.

The division necessarily includes many varieties of ore, and several different methods of reduction are applied to them. The gold ores of California, Oregon, and Alaska are as a rule free milling, though concentration and cyaniding of tailings are very often combined with the simple amalgamation process. The ores of the Homestake mine in South Dakota fall into the same general class as do the Telluride and Ouray siliceous ores and ores from many scattering occurrences in Idaho, Colorado, and Arizona.

In many cases in Colorado, in Yavapai County, Arizona, and in other places, the siliceous ore contains but little free gold and is concentrated without amalgamation.

The pan-amalgamation process for siliceous gold-silver ores has become almost obsolete, and is used at only a few places in Montana, Nevada, Texas, and Arizona. The siliceous ores of western Nevada at Goldfield, Tonopah, Rhyolite, and Silver Peak are now largely reduced in mills near the mines, and in consequence lower-grade ores can be treated. Full descriptions of these mills were contained in the report for 1907. The process often used combines plate amalgamation, concentration, and cyaniding.

The quartzose gold ores formed by replacement of limestone are generally cyanided and yield a total of several hundred thousand ounces. The three most prominent localities are the Camp Floyd (Mercur) district in Utah, the Black Hills of South Dakota, the Moccasin Mountains, and the Little Rocky Mountains of Montana.

The dry or siliceous ores further include the quartzose ores of Cripple Creek, Colorado, in which the prominent characteristic is the occurrence of large quantities of gold tellurides. These ores are partly smelted, partly chlorinated, and partly cyanided, all three processes being applicable.

There is, finally, a large class of dry ores which contain pyrite and other sulphides, and which are best treated by the smelting process, with or without concentration. Colorado contributes by far the largest quantity of these ores, among which those of Leadville are of particular importance.

Copper ores.—In 1908 gold valued at $4,812,993 was obtained from the treatment of copper ores, against $5,625,842 in 1907. At first glance it would seem that with a larger copper production in 1908 than in 1907 a correspondingly greater quantity of gold should have been extracted. There was, in fact, practically no change in Arizona and a notable increase in Montana, the two being the most important copper-producing States; there were also decided gains in California and Idaho; but all these could not offset the great loss in Utah, due to a diminished supply of copper ores rich in gold from the Tintic and Bingham camps. Utah copper ores yielded only about $2,300,000, or $1,000,000 less than in 1907. Losses are also noted in the production of Alaska and Colorado. The relative rank of the principal States in the output of gold from copper ores was Utah, Arizona, Montana, California, Nevada, New Mexico, and Alaska.

The copper ores which contain gold are chiefly of the sulphide class. Chalcocite is the most abundant mineral, though in some districts chalcopyrite prevails. Oxidized ores are still extensively mined at Bisbee, Ariz., and Tintic, Utah; also at the Snowstorm mine in Idaho, and at some other places. The sulphide ores are ordinarily concentrated and smelted; the oxidized ores are smelted without concentration. The gold is recovered by electrolytic refining of the copper.

Lead ores.—From lead ores and copper-lead ores were recovered in 1908 $1,547,414 in gold, against $2,669,439 in 1907. In spite of the great reduction of the lead production in Colorado there was little change in the gold won from lead ores in that State. At Leadville special effort was made to mine ores rich in gold. Lessened production is recorded from Montana and Idaho. The principal cause of the great decrease referred to above is found in Utah, whence only about $414,000 were obtained from lead ores, against nearly $1,000,000 in 1907. Lessened activity at Tintic and Bingham camps was, here too, the responsible factor. The States producing gold from lead ores ranked as follows: Utah, Colorado, Idaho, and Montana. The first two States are far ahead of the others. The lead ores are mainly of the sulphide class; large quantities of oxidized ores are, however, still furnished by the Tintic district.

Zinc and zinc-lead ores.—Only small amounts of gold are recovered from zinc ores. Montana, Arizona, and Utah yielded together $24,674, most of it from Montana. Zinc-lead ores, chiefly from Colorado, yielded $101,795 in gold, against $42,153 in 1907. Most of the increased Colorado yield for 1908 came from Creede, not from Leadville.

DISTRIBUTION OF SILVER PRODUCT IN 1908.

The following table shows the source of silver in the United States in 1908, by kinds of ore and by States:

Source of silver in 1908 in States and Territories, as reported from the mines to the United States Geological Survey, by kinds of ore and by States, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alabama	4	278	.....	.....	.....	.....	.....	282
Alaska	70,104	31,966	33,602	.....	.....	.....	.....	135,672
Arizona	258	899,072	1,777,266	129,050	700	2,104	.....	2,808,450
California	71,185	483,483	1,031,381	59,600	.....	1,629	.....	1,647,278
Colorado	2,119	5,553,591	193,206	1,501,803	.....	941,394	713,320	8,905,433
Georgia	42	158	.....	.....	.....	.....	.....	200
Idaho	2,687	918,094	631,261	5,917,034	.....	905	.....	7,469,981
Illinois	.....	.....	.....	2,051	.....	.....	.....	2,051
Massachusetts, New Hampshire, and Pennsylvania	.....	.....	6,270	.....	.....	.....	.....	6,270
Michigan	.....	.....	241,055	.....	.....	.....	.....	241,055
Missouri	.....	.....	.....	49,131	.....	.....	.....	49,131
Montana	4,100	1,715,386	8,274,951	301,158	35,861	24,743	.....	10,356,199
Nevada	2,013	8,953,654	29,321	482,018	.....	41,458	.....	9,508,464
New Mexico	153	364,335	24,768	14,870	.....	918	.....	405,044
North Carolina	114	1,146	.....	.....	.....	.....	.....	1,260
Oregon	5,851	37,464	287	.....	.....	.....	.....	43,602
South Carolina	10	65	151	.....	.....	.....	.....	226
South Dakota	179	245,083	.....	3,500	.....	.....	.....	248,762
Tennessee	.....	.....	57,696	.....	.....	.....	.....	57,696
Texas	.....	435,163	.....	9,173	.....	.....	.....	444,336
Utah	63	163,285	2,620,680	5,570,548	1,044	86,132	9,586	8,451,338
Virginia	3	21	93	119	.....	.....	.....	236
Washington	392	59,794	19,211	9,426	.....	.....	.....	88,823
Wyoming	8	.....	3,990	.....	.....	.....	.....	3,998
	159,285	19,862,038	14,945,189	14,049,481	37,605	1,099,283	722,906	50,875,787

[a] Philippines and Porto Rico not included in above table.

General statement.—The total silver product for 1908 was, as usual, divided chiefly between siliceous ores, copper ores, and lead ores. The proportion from the various ores was, however, somewhat different from 1907. Only a small quantity was recovered from placers, most of which is credited to Alaska and California. In percentages of the total the division was as follows: Siliceous ores, 39.1 per cent; copper ores, 29.4 per cent; lead ores and lead-copper ores, 29.7 per cent; zinc and zinc-lead ores, 1.5 per cent; and placers, 0.3 per cent.

Dry and siliceous ores.—The total quantity from this source was 19,862,038 fine ounces, against 19,038,042 ounces in 1907. The important States ranked as follows: Nevada, Colorado, Montana, Idaho, Arizona, California, South Dakota, and Utah. The production of none of the remaining States reached 100,000 ounces. The increase noted above was mainly the net result of a loss of 1,900,000 ounces in Colorado, and an increase of about 2,500,000 ounces in Nevada. Among the States of less importance in regard to these ores Idaho, Texas, Utah, and Washington increased their production; but this was offset by decreases in Arizona, New Mexico, Oregon, and South Dakota. The larger part of these ores are not silver ores proper, but ores carrying both silver and gold. The ores of Tonopah, which now furnish most of the silver from Nevada, contain, by value,

an average of twice as much silver as gold. As stated above, most of these ores are now milled. Three-fifths of the product of Colorado was derived from the ores of the "San Juan country," which are largely gold-silver ores of milling grade with some smelting ores; there was no decrease in the quantity from this source, but the great falling off was in the low-grade ores from Leadville and Aspen, which contain little gold but some lead, though not enough to be classed as lead ores. The product of Montana is now mostly derived from Granite, Jefferson, and Silverbow counties.

Silver is recovered from siliceous ores by amalgamation or cyanide processes; some rich siliceous ores are smelted, and the silver is obtained by desilverization of lead bullion or by electrolytic refining of copper.

Copper ores.—From copper ores 14,945,189 ounces were recovered in 1908, an increase of almost 1,000,000 ounces as compared with 1907. The States ranked as follows: Montana, Utah, Arizona, California, Idaho, Michigan, and Colorado; none of the other States produced over 60,000 ounces. Here, as in the gold production, the decreased output of the high-grade ores of Bingham and Tintic camps in Utah was severely felt, causing a decrease for Utah of 800,000 ounces. This was more than offset by an increase of about 1,100,000 ounces in Montana derived from the greater copper production of Butte, by an increase from Shasta County copper ores of California of about 700,000 ounces, and by an increase of 800,000 ounces from the Arizona copper camps. The product of Arizona was derived mainly from the Bisbee, United Verde, and Silver Bell districts in the order named.

Lead ores.—The total of silver derived from lead ores in 1908 was 15,148,764 ounces, against 17,808,636 ounces in 1907. The important States ranked as follows: Idaho, Utah, Colorado, Nevada, Montana, and Arizona. None of the other States reached a production of 100,000 ounces from these ores. The heavy decrease of about 2,600,000 ounces was mainly due to Utah, which only produced 5,656,680 ounces in 1908, and here again the cause was decreased activity at Bingham and Tintic districts, as well as at Park City. In Colorado little change is noted. Comparatively small quantities of high-grade lead ores come from Leadville, and the silver product from this source was mainly derived from Creede and the "San Juan country." Oxidized argentiferous lead ores are still furnished by Tintic, Utah, Aspen, Colorado, and other places in Colorado, Arizona, Nevada, and New Mexico.

Zinc and zinc-lead ores.—The zinc ores proper contributed only a small output of silver; such ores were shipped from Montana, Utah, and Arizona. The total product was only 37,605 ounces. The zinc-lead ores are produced chiefly in Colorado and in 1908 yielded about 723,000 ounces, against 1,475,000 ounces in 1907. They are usually concentrated into zinc and lead products. The decrease in the activity of zinc mining resulted in a greatly reduced yield. As usual, Leadville, in Colorado, contributed the greatest output, but smaller quantities were also mined in Utah.

COPPER.

By B. S. Butler.

INTRODUCTION.

In the production of metallic copper suitable for commercial purposes three distinct processes are usually required, namely, mining, smelting, and refining. The Lake Superior native copper district is the only important producer where these three processes are not entirely distinct. It is possible, therefore, to ascertain the copper output of the country by collecting statistics from the mines, from the smelters, and from the refiners, and each of these sets of figures has its advantages and its disadvantages. The mine figures have the advantage of giving the most accurate distribution of the production, but are less accurate in total quantity of copper recovered; the smelter figures permit of reasonably accurate distribution and also furnish the actual recovery of copper from the ores treated during the year; the refinery figures furnish the best measure of the copper made available for commercial uses during the year, but at this stage of manufacture the accurate distribution to the State of origin, or even the separation of copper derived from domestic and from foreign sources, is uncertain.

Statistics for 1908 showing the production of each of these stages of manufacture have been collected by the United States Geological Survey, and are presented in the following report.

Since the same material passes through the three processes of manufacture at successive periods, usually requiring two to three months from the time it is taken from the mine before it reaches the stage of refined copper, the year's production as recorded for the different stages does not represent the same materials—that is, the refinery production for the calendar year 1908 represents the mine production from about October 1, 1907, to October 1, 1908. The three sets of figures representing the successive stages of manufacture do not therefore necessarily agree, although they should not differ greatly if the condition of the industry is normal. The mine and the smelter figures will differ by the difference in the quantity of ore, matte, etc., in stock at the beginning and at the end of the year, and by the difference in the quantity of copper reported by the mines and that recovered by the smelters. This difference is due to the fact that considerable copper is recovered from sulphur, lead, and zinc ores carrying values in copper so low that the mines do not receive pay for and frequently do not report the copper content of the ore, although it is eventually recovered by the smelters. The smelter and refinery figures will differ by the increase or decrease in stock of blister, etc., at the beginning and at the end of the year, and by the loss in refining.

Since the smelter production permits very accurate distribution as to source by States and also gives the actual output of copper, it is considered in this report as the production of the country. It is made up of the production of blister copper and of furnace-refined or ingot copper of the Lake district, plus the Michigan copper cast into anodes for electrolytic refining.

SUMMARY OF STATISTICS.

The following statistical statement summarizes the copper industry in the United States in 1907 and 1908:

Summary of statistics of the copper industry in the United States in 1907 and 1908.

	1907.	1908.
Production of copper:		
Smelter output.....pounds..	868,996,491	942,570,721
Mine production.....do....	847,151,015	956,840,578
Refinery production of new copper—		
Electrolytic.....do....	592,326,608	656,179,349
Lake.....do....	178,534,141	195,503,099
Casting.....do....	13,410,678	24,166,681
Total domestic.....do....	784,271,427	875,849,129
Total domestic and foreign.....do....	1,032,516,247	1,095,700,123
Total new and old copper.....do....	1,093,001,831	1,117,913,800
Total ore treated.....short tons..	21,403,000	22,358,875
Copper ore treated.....do....	20,253,000	22,290,886
Average yield of copper.....per cent..	2.11	2.08
Imports.....pounds..	252,620,054	218,705,487
Exports, in terms of refined copper.....do....	465,496,007	618,613,842
Consumption:		
Total new copper.....do....	485,000,000	480,000,000
Total new and old copper.....do....	545,000,000	503,000,000
World's production.....do....	1,589,809,300	1,667,098,000

PRODUCTION.

GENERAL CONDITION OF INDUSTRY.

As compared with the year 1907, the commercial conditions of the copper industry during 1908 were very stable. The variation in the monthly averages of New York quotations was only 1.54 cents, as compared with 11.90 cents for 1907. As compared with the prices for the years immediately preceding, the price of copper remained low throughout the year, although it was almost exactly the same as the average price for the twenty-five years from 1883 to 1907; the average price for 1908 was 13.20 cents and that for the preceding period of twenty-five years was 13 to 13.25 cents.[a]

The year opened with large stocks of copper on hand, although several important producers were restricting their output. Other companies, however, were making their normal production or even increasing their output in order to reduce costs. It soon became apparent to the companies that had reduced their output that they were doing so to the advantage of their competitors, and a general resumption of production followed, so that by the middle of the year all the leading producers in the United States were making a

[a] Mineral Resources U. S., for 1907, pt. 1, 1908, p. 574.

normal or even an increased production. The Great Falls plant of the Amalgamated Company was idle for a considerable period after the general resumption, but this was due to damage by flood. During the year the mines of the Ely district, Nevada, and the Balaklala mine, Shasta County, Cal., began production; and the Bully Hill mine, also in Shasta County, resumed operations after about two years of idleness while the smelting works were being rebuilt, and the mines of the Bingham district, Utah, increased their outputs.

The domestic consumption of copper did not fall far below that of 1907, which, with the record export of 661,876,127 pounds caused by the stimulus of low prices, resulted in a small decrease in stocks during the year, though copper was rapidly accumulating during the last months.

A notable feature of the industry for the year was the decrease in cost of production. This was brought about by a general policy of economy in operations, including the lowering of wages and in some cases in the mining of higher-grade ores. Probably the greatest saving resulted from the increased efficiency of labor, which had become notoriously inefficient during the boom times of preceding years. Many companies producing copper at a high cost were forced to cease operations with the fall in price; and still others will come to this if present prices hold. However, according to the statements of producers, a large part of the output of 1908 was produced at a profit. Several large properties, capable of producing copper at a low cost, have just begun to contribute to the output, and other mines will soon be adding to the production. It therefore seems probable that present demands for copper can be met by companies able to produce it with a reasonable profit at prices no higher than those of 1908. If this is true, there seems to be little to encourage the continued operation of developed mines that are producing at a loss under present conditions. The continued low price of copper would, however, naturally cause an increase in consumption, which, unless more than balanced by increased production, would tend to raise the price to a somewhat higher level.

An important event early in 1909 was the formation of the Copper Producers' Association. This includes all of the leading producers of the country. The object is to collect and give out accurate information relative to the production, export, and domestic consumption of copper. The industry has suffered much in the past from erroneous reports and estimates concerning stocks, etc., some of them published for the purpose of influencing the market. The general purpose of the organization is to furnish accurate information to those interested in the industry. The association issued its first report on February 10, 1909, and has made monthly reports since that date. The usefulness of these reports seems to have met the expectations of the organizers.

SMELTER AND MINE PRODUCTION.

GENERAL STATEMENT.

The production of copper in 1908 by smelters from copper-bearing materials from the United States was 942,570,721 pounds. The production for 1907 was 868,996,491 pounds, and for 1906, 917,805,682 pounds. The production for 1908 was the largest in the history of

the industry, exceeding the record production of 1906 by 24,765,039 pounds and that of 1907 by 73,574,230 pounds, or 8.4 per cent.

The yearly production of copper in the United States from 1845 to 1908, inclusive, together with the actual and relative changes from each preceding year, is given in the following table:

Magnitude and growth of copper production in the United States from 1845 to 1908, inclusive.

Year.	Production.	Increase.		Average annual increase by decades.	
	Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
1845	224,000				
1846	336,000	112,000	50.0		
1847	672,000	336,000	100.0	242,400	50.0
1848	1,122,000	450,000	67.0		
1849	1,568,000	426,000	40.0		
1850	1,456,000	[a] 112,000	[a] 7.1		
1851	2,016,000	560,000	23.1		
1852	2,464,000	448,000	22.2		
1853	4,480,000	2,016,000	81.8		
1854	4,990,000	510,000	12.5		
1855	6,720,000	1,730,000	33.3	1,467,200	27.0
1856	8,960,000	2,240,000	33.3		
1857	10,752,000	1,792,000	20.0		
1858	12,320,000	1,568,000	14.6		
1859	14,112,000	1,792,000	14.5		
1860	16,128,000	2,016,000	14.3		
1861	16,800,000	672,000	4.1		
1862	21,160,000	4,360,000	20.0		
1863	19,040,000	[a] 2,120,000	[a] 5.5		
1864	17,920,000	[a] 1,120,000	[a] 5.9		
1865	19,040,000	1,120,000	6.3	1,209,600	6.1
1866	19,936,000	896,000	4.7		
1867	22,400,000	2,464,000	12.3		
1868	25,984,000	3,584,000	16.0		
1869	28,000,000	2,016,000	7.7		
1870	28,224,000	224,000	1.0		
1871	29,120,000	896,000	3.2		
1872	28,000,000	[a] 1,120,000	[a] 3.8		
1873	34,720,000	6,720,000	24.0		
1874	39,200,000	4,480,000	12.9		
1875	40,320,000	1,120,000	2.9	3,225,600	7.2
1876	42,560,000	2,240,000	5.6		
1877	47,040,000	4,480,000	10.5		
1878	48,160,000	1,120,000	2.4		
1879	51,520,000	3,360,000	7.0		
1880	60,480,000	8,960,000	17.4		
1881	71,680,000	11,200,000	18.6		
1882	90,646,232	8,966,232	12.5		
1883	115,526,053	24,886,221	27.4		
1884	144,946,653	29,420,600	25.5		
1885	165,875,766	20,929,113	14.4	18,930,349	14.8
1886	156,735,381	[a] 9,140,385	[a] 5.5		
1887	180,920,524	24,185,143	15.4		
1888	226,361,466	45,440,942	25.1		
1889	226,775,962	414,496	.2		
1890	259,763,092	32,987,130	14.5		
1891	284,121,764	24,358,672	9.4		
1892	344,998,679	60,876,915	21.5		
1893	329,354,398	[a] 15,644,281	[a] 4.8		
1894	354,188,374	24,833,976	7.5		
1895	380,613,404	26,425,030	7.4	34,635,407	9.1
1896	460,061,430	79,448,026	20.9		
1897	494,078,274	34,016,844	7.4		
1898	526,512,987	32,434,713	6.6		
1899	568,666,921	42,153,934	8.0		
1900	606,117,166	37,450,245	6.6		
1901	602,072,519	[a] 4,044,647	[a] .7		
1902	659,508,644	57,436,125	9.5		
1903	698,044,517	38,535,873	5.8		
1904	812,537,267	114,492,750	16.4	42,562,275	5.8
1905	888,784,267	76,247,000	9.4		
1906	917,805,682	29,021,415	3.3		
1907	868,996,491	[a] 48,809,191	[a] 5.3		
1908	942,570,721	73,574,230	8.4		

[a] Decrease.

The figures, except for 1908, are taken from the previous volumes of Mineral Resources of the United States. Statistics from 1882 to 1908, inclusive, are based on the returns to the Geological Survey by the copper-producing companies. Figures for the years prior to 1882 were compiled by the United States Geological Survey from the best sources available. Reliable figures for years previous to 1845 are not obtainable. The year 1845, however, marks the entrance of the Lake Superior district into the ranks of producers and is really the beginning of important production of copper in this country. The industry has shown a steady and in recent years a very rapid growth. The few years when there has been a decrease in production, as compared with the preceding year, have in almost every case been years of general financial depression or panic, and the copper industry has been quick to recover when normal business conditions were restored. The year 1908 seems to be no exception to the rule. The year 1907 showed a marked decrease, due to the financial panic occurring in the latter part of that year. The year 1908 shows a marked increase over the production of 1907, and also over that of 1906, and this notwithstanding the fact that the financial depression extended well into the year 1908 and that copper production was curtailed for a part of the year. It is expected that 1909 will show fully the normal increase.

A more detailed discussion of the fluctuation in production has been published in a recent volume of Mineral Resources of the United States[a] and need not be repeated here.

SMELTER RETURNS.

The figures of smelter production for 1908 are based on returns made confidentially to the Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries to aid in the accurate distribution of the output, sincere thanks are extended. The following list gives the names of the owning or operating companies, the location, and the final copper product of all known plants which contributed to the copper production of 1908:

Smelting plants that treated United States copper in 1908.

Location.	Company.	Final copper product.
UNITED STATES.		
Alaska: Hadley	Alaska Mines Securities Co	Matte.
Arizona:		
Clifton	Arizona Copper Co	Blister.
Do	Shannon Copper Co	Do.
Douglas	Calumet and Arizona Mining Co	Do.
Do	Copper Queen Consolidated Mining Co	Do.
Globe	Old Dominion Copper Mining and Smelting Co.	Do.
Jerome	United Verde Copper Co	Do.
Morenci	Detroit Copper Mining Co	Do.
Sasco	Southern Arizona Smelting Co	Do.
California:		
Campo Seco	Penn Chemical Co	Matte.
Winthrop	Bully Hill Copper Mining and Smelting Co	Do.
Coram	First National Copper Co	Blister.
Kennett	Mammoth Copper Mining Co	Do.
Martinez	Mountain Copper Co	Do.
Do	Peyton Chemical Co	Matte.

[a] Mineral Resources U. S. for 1907, pt. 1, 1908, p. 576.

Smelting plants that treated United States copper in 1908—Continued.

Location.	Company.	Final copper product.
UNITED STATES—continued.		
California—Continued.		
Needles	Arizona-Mexican Mining and Smelting Co	Matte.
Selby	Selby Smelting and Lead Co.[a]	Lead furnace matte.
Colorado:		
Canyon City	United States Smelting Co	Matte.
Denver	American Smelting and Refining Co	Lead furnace matte.
Do.	Boston and Colorado Smelting Co	Matte.
Durango	American Smelting and Refining Co	Lead furnace matte.
Leadville	do	Do.
Pueblo	do	Do.
Salida	Ohio and Colorado Smelting and Refining Co	Do.
Idaho:		
Ivers	Lost Packer Mining Co	Matte.
Ponderay	Idaho Smelting and Refining Co	Lead furnace matte.
Illinois:		
Aurora	American Smelting and Refining Co	Matte.
Blue Island	Chicago Copper Refining Co	Casting.
Maryland: Baltimore	Baltimore Copper Smelting and Rolling Co.[a]	Electrolytic and casting.
Michigan:		
Hancock	Lake Superior Smelting Co	Anodes and Lake.
Do.	Quincy Mining Co	Do.
Houghton	Michigan Smelting Co	Do.
Hubbell	Calumet and Hecla Mining Co	Do.
Missouri: Fredericktown	North American Lead Co	Blister and electrolytic.
Montana:		
Anaconda	Washoe Copper Co	Blister.
Butte	Colusa-Parrot Mining and Smelting Co	Do.
Do.	Pittsburg and Montana Copper Co	Do.
East Helena	American Smelting and Refining Co	Lead furnace matte.
Great Falls	Boston and Montana Consolidated Copper and Silver Mining Co.	Blister and electrolytic.
Nebraska: Omaha	American Smelting and Refining Co	Blister.
Nevada: McGill	Steptoe Valley Mining and Smelting Co	Do.
New Jersey:[b]		
Chrome	United States Metals Refining Co	Electrolytic and casting.
Maurer	American Smelting and Refining Co	Electrolytic.
Newark	Balbach Smelting and Refining Co	Electrolytic and casting.
Perth Amboy	Raritan Copper Works	Electrolytic.
New Mexico:		
Deming	National Mining and Smelting Co	Lead furnace matte.
Oro Grande	Southwest Smelting and Refining Co	Matte.
New York:		
Black Rock	Buffalo Smelting Works	Lake and electrolytic.
Laurel Hill	Nichols Copper Co	Electrolytic and casting.
Oregon: Takilma	Takilma Smelting Co	Matte.
Pennsylvania:[b] Carnegie	Pennsylvania Smelting Co	Lead furnace matte.
Tennessee:		
Copperhill	Tennessee Copper Co	Blister.
Isabella	Ducktown Sulphur, Copper and Iron Co. (Ltd.)	Matte.
Texas: El Paso	American Smelting and Refining Co	Do.
Utah:		
Bingham	Yampa Smelting Co	Blister.
Bingham Junction	United States Smelting Co	Do.
Garfield	Garfield Smelting Co.[a]	Do.
Murray	American Smelting and Refining Co	Lead furnace matte.
Ogden	Independent Smelting Co	Matte.
Silver City	Tintic Smelting Co	Lead furnace matte.
Virginia: West Norfolk	Eustis Smelting Co	Matte.
Washington:		
Everett	Puget Sound Reduction Co.[a]	Lead furnace matte.
Northport	Northport Smelting and Refining Co	Matte.
Tacoma	Tacoma Smelting Co.[a]	Blister.
Wyoming: Encampment	Penn-Wyoming Copper Co	Do.
CANADA.		
British Columbia:		
Greenwood	British Columbia Copper Co. (Limited)	Do.
Trail	Consolidated Mining and Smelting Co. of Canada (Limited).	Matte.
MEXICO.		
Aguas Calientes: Aguas Calientes.	American Smelting and Refining Co	Blister.

[a] Subsidiary of American Smelters Securities Company.
[b] This list does not include a smelter in New Jersey and one in Pennsylvania, both of which make blister from material solely of foreign origin.

Sixty-eight plants treated copper-bearing materials from the United States in 1908, as compared with 81 in 1907. Nineteen plants that were producers from United States ores in 1907 did not produce in 1908. Most of these were small plants, in several cases remote from railroad facilities and in consequence unable to operate under the conditions of 1908. Exceptions to this were the smelters in Utah that were closed by the courts, and 3 foreign smelters that treated custom ores from the United States in 1907 and not in 1908.

Of the 6 plants producing in 1908 and not in 1907, 5 were either new or were undergoing repairs in 1907, and 1 foreign smelter treated custom ores in 1908 and not in 1907.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of the furnace refined copper and the copper cast into anodes for electrolytic refining. In the case of blister copper the figures represent the fine copper content. A small quantity of electrolytic copper was produced without passing through the intermediate stage of blister copper, and some casting copper was produced direct from ore and matte. Both of these are included in the smelter production.

One large company failed to report its production of blister copper. In order to make the output of this company correspond as nearly as possible to the basis of blister copper, the copper content of bluestone produced in the refining of the company's output has been added to the output of refined copper.

The following table shows the production of blister copper from different sections. Smelters that produced only matte are not included in this distribution:

Production of copper in 1908, apportioned according to locality in which smelted to blister, in pounds.

Locality.	Domestic.	Foreign.[a]	Total.
Arizona	286,280,676	15,760,305	302,040,981
Montana	256,048,301	.....	256,048,301
Michigan	183,425,808	.....	183,425,808
Utah and Nevada	81,678,217	.....	81,678,217
California and Washington	40,366,198	5,833,411	46,199,609
Illinois, Missouri, Nebraska, and Wyoming	18,209,841	.....	18,209,841
Maryland, New Jersey, and New York	56,578,184	45,074,675	101,652,859
Tennessee	14,573,750	.....	14,573,750
Total by domestic plants	937,160,975	66,668,391	1,003,829,366
Total by foreign plants	5,409,746	.....	.....
Grand total from domestic ores	942,570,721	.....	.....

[a] The production from foreign materials by three plants is approximate.

As will be seen by comparing this table with the table showing the production by States and districts, with few exceptions ore is reduced to blister copper before being shipped from the district. The exceptions in the case of important producing States are Michigan and Colorado. In the case of the Michigan output the shipping product is high-grade concentrate transported by lake boats to Buffalo at a low cost. In the case of Colorado the copper is largely produced in lead furnaces and shipped to Omaha for conversion.

Arizona treated considerable Mexican ore, and ore and matte from British Columbia were treated in this country, though not to the

extent of former years, the larger Canadian plants reducing their product to blister for shipment. Considerable matte from the United States were smelted in Mexico, and ore from the United States was reduced to matte in British Columbia and returned to this country for conversion. A large tonnage of ore and matte from foreign sources was treated by the seaboard smelters.

The following table distributes the production according to the locality where first smelted. It differs from the preceding table in that it excludes from the blister smelters all copper derived from custom matte and includes the product of matte smelters derived from domestic ores.

Copper product from domestic ore and concentrates in 1908, apportioned according to locality in which first smelted, in pounds.

Alaska, Oregon, Washington, and Canada	9,138,147
Arizona and Mexico	291,690,422
California	40,983,482
Colorado	12,829,304
Idaho and Wyoming	3,144,609
Michigan	183,425,808
Montana	256,578,968
Missouri, Nebraska, and Illinois	1,467,711
Utah and Nevada	80,604,358
New Mexico and Texas	6,800,146
Tennessee	19,568,666
New York, New Jersey, Pennsylvania, Maryland, and Virginia	39,154,606
	945,386,227

It will be seen by comparing this table with that giving the production by States that there is a very close correspondence. No large copper-producing camps of this country in 1908 shipped their ore or concentrates to any great distance from the mines before smelting at least to matte. Several of the smaller camps, however, have only matte smelters, this product being shipped for further treatment. Matte smelters produced about 36,500,000 pounds of copper during 1908, a marked reduction from about 76,000,000 pounds in 1907. This decrease is due to the fact that important matte producers in 1907 produced blister in 1908 and that several small matte smelters that operated in 1907 were closed during 1908.

It will be noted that the total in this table is larger than that in the preceding table, showing the production by blister smelters. This difference is due to the fact that more matte was produced by these plants during the year than was converted. In the latter part of 1907 some of the small matte smelters were closed on account of the low price of copper, and their stock of matte had been entirely converted by January 1, 1908. During the year some of these smelters resumed operations and some new smelters began production. A considerable quantity of matte produced by these plants during the year had not reached the stage of blister copper before January 1, 1909.

MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1908. These mines reported 956,840,578 pounds of copper, or 14,269,857 pounds more than the smelters. In the case of the large copper producers, with few exceptions, the mines and smelters are

under the same management and the two are reported on the same basis. In the case of mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion, there is likely to be considerable discrepancy, as the mines may report a considerable quantity that has not reached the stage of blister by the close of the year and is consequently not included in the smelter production. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or close of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. A number of small operators report the copper in their ores on the basis of commercial assay. Considerable copper is also recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for, and consequently in some instances is not reported by the mines. At the close of the year there was known to be 17,800,000 pounds of copper in the form of ore and concentrates in storage at the smelters in excess of the quantity at the beginning of the year, and the actual quantity was probably still greater. This would leave a balance of about 3,500,000 pounds in favor of the smelters. Approximately 4,000,000 pounds of copper was recovered by the smelters that was not reported by the mines, and if this be added to the mine output it gives a difference unaccounted for of about 500,000 pounds, or less than one-tenth of 1 per cent of the total output.

PRODUCTION BY STATES.

Twenty-four States and Territories contributed to the copper production of 1908. The first table on the next page shows the mine and smelter output of individual States for 1907 and 1908. Several small producing States are grouped to avoid disclosing individual production.

In the distribution of the blister output to the States of origin it is necessary to have reports not only from blister producers, but also from matte smelters, as the matte is credited by the smelter that converts it to the State from which it was received, while the matte smelter may have received its ores from several States. In the adjustment of the products of these matte smelters slight errors in the distribution of the blister production are probably introduced.

According to smelter returns the three leading copper States, Arizona, Montana, and Michigan, produced 81 per cent of the total output of 1908, as compared with 80 per cent in 1907; the five leading States, including Utah and California, produced nearly 93 per cent of the total output in 1908, as compared with 92 per cent in 1907.

Production of copper by smelter returns in 1907 and 1908, compared with mine returns for same years, by States, in pounds.

State.	1908.				1907.	
	Production.			Mine returns.	Production, smelter returns.	Mine returns.
	Rank.	Percentage of total.	Smelter returns.			
Alaska	11	0.47	4,438,836	4,585,362	7,034,763	6,308,786
Arizona	1	30.72	289,523,267	285,858,133	256,778,437	254,879,489
California	5	4.20	39,643,835	38,776,881	33,696,602	28,528,020
Colorado	7	1.48	13,943,878	9,997,738	13,998,496	7,724,590
Idaho	9	.77	7,256,086	10,041,850	9,707,299	10,890,731
Massachusetts	21	.....	7,863	.....	.....	.....
Michigan	3	23.58	222,289,584	223,286,700	219,131,503	217,767,232
Montana	2	26.79	252,503,651	251,667,795	224,263,789	220,108,792
Nevada	8	1.30	12,241,372	15,598,788	1,998,164	1,782,571
New Hampshire	16	.01	[a] 135,139	[b] 188,756	.....	.....
New Mexico	10	.53	4,991,351	6,112,630	10,140,140	10,990,015
North Carolina	17	.01	[a] 29,391	[c] 20,993	544,040	582,082
Oregon	14	.03	271,191	291,377	518,694	554,104
Tennessee	6	2.09	19,710,103	19,459,501	19,745,119	18,893,115
Utah	4	7.57	71,370,370	86,848,812	66,418,370	64,256,884
Vermont	.....	.....	.....	.....	696,102	650,425
Virginia	18	.....	25,087	24,775	57,008	58,880
Washington	15	.02	162,201	312,030	122,263	297,812
Wyoming	12	.26	2,416,197	2,452,049	3,026,004	2,257,650
Georgia	.....	.....	.....	.....	.....	.....
Maryland	24	.....	[a] 30,488	.....	90,655	619,737
Alabama	20	.....		.....		
South Carolina	23	.....		.....	.....	
Texas	19	.....		.....	.....	
South Dakota	22	.....		.....	.....	
Missouri and unapportioned	13	.17	1,580,831	[d] 1,316,308	1,299,043	
	.....	.....	942,570,721	956,840,578	868,996,491	847,151,015

[a] The change from the figures in the advance statement is due to corrections in the distribution made by the producing companies after the publication of that statement.
[b] Includes Massachusetts.
[c] Includes South Carolina.
[d] Missouri and all other States.

In the following table is given the blister output of the leading copper districts of the country:

Blister copper production of principal districts in 1908, in pounds.

District or region.	State.	Approximate smelter output.	Percentage of total production.	Rank.
Butte	Montana	252,500,000	26.79	1
Lake Superior	Michigan	222,000,000	23.55	2
Bisbee	Arizona	129,000,000	13.69	3
Morenci	....do	77,000,000	8.17	4
Bingham	Utah	56,000,000	5.94	5
Globe	Arizona	36,000,000	3.82	6
Jerome	....do	36,000,000	3.82	7
Shasta County	California	32,500,000	3.45	8
Ducktown	Tennessee	19,700,000	2.09	9
Ely	Nevada	9,400,000	1.00	10
Silverbell	Arizona	6,700,000	.71	11
Coeur d'Alene	Idaho	6,400,000	.68	12
Tintic	Utah	5,500,000	.58	13
Frisco	....do	5,500,000	.58	14
Leadville	Colorado	4,600,000	.49	15
Calaveras County	California	4,500,000	.48	16
Santa Rita	New Mexico	4,000,000	.42	17
Southeastern Alaska	Alaska	3,000,000	.32	18
Encampment	Wyoming	2,300,000	.24	19
Lucin	Utah	2,300,000	.24	20
San Juan	Colorado	2,200,000	.24	21
Total	.....	917,100,000	97.30	
All others	.....	25,400,000	2.70	
Grand total	.....	942,500,000	.....	

As shown by the table, 21 districts in 1908, against 22 districts in 1907, produced more than 2,000,000 pounds of blister copper each. The 21 leading districts in 1908 produced over 97 per cent of the copper output of the country; the 22 districts in 1907 produced about 96 per cent. In 1908, the 9 leading districts, only 1 of which reported less than 20,000,000 pounds, produced over 91 per cent of the total output, as compared with a little less than 90 per cent for the same districts in 1907. This shows the tendency toward increased output by the large producers and the shutting down of small mines that resulted from the fall in the price of copper. At the close of the year the relative difference in output between large and small producers was probably greater than is shown by the average for the year, as there was considerable curtailment of output by some large producers during the early part of the year, although few of the small producers had resumed operations at the close of 1908.

The following table shows the production for each State for which separate statistics have been kept for the last ten years:

Production of copper in the United States, 1899–1908, by States, in pounds.

State.	1899.	1900.	1901.	1902.	1903.
Alaska					1,339,590
Arizona	133,054,860	118,317,764	130,778,611	119,944,944	147,648,271
California	26,221,897	28,511,225	33,667,456	25,038,724	17,776,756
Colorado [a]	11,643,608	7,826,949	9,801,783	8,422,030	4,158,368
Idaho	110,000	290,162	480,511	227,500	778,906
Michigan	147,400,338	145,461,498	156,289,481	170,609,228	192,400,577
Montana	225,126,855	270,738,489	229,870,415	288,903,820	272,555,854
New Mexico	3,935,441	4,169,400	9,629,884	6,614,961	7,300,832
Nevada	556,755	407,535	593,608	164,301	[b] 150,000
South Dakota	17,020	15,147	753,510	445,663	173,202
Utah	9,584,746	18,354,726	20,116,979	23,939,901	38,302,602
Washington				209,297	80,758
Wyoming	3,104,827	4,203,776	2,698,712	889,228	1,023,189
Eastern States	4,410,554	4,820,495	6,860,039	13,599,047	13,855,612
Southern States					
Middle States					
Lead desilverizers and unapportioned	[b] 3,500,000	[b] 3,000,000	531,530	[b] 500,000	[b] 500,000
	568,666,921	606,117,166	602,072,519	659,508,644	698,044,517

State.	1904.	1905.	1906.	1907.	1908.
Alaska	2,043,586	4,900,866	8,665,646	7,034,763	4,438,836
Arizona	191,602,958	226,854,461	262,566,103	256,778,437	289,523,267
California	28,529,023	16,697,489	28,153,202	33,696,602	39,643,835
Colorado [a]	9,506,944	9,404,830	7,427,253	13,998,496	13,943,878
Idaho	2,158,858	7,321,585	8,578,046	9,707,299	7,256,086
Michigan	208,309,130	230,287,992	229,695,730	219,131,503	222,289,584
Montana	298,314,804	314,750,582	294,701,252	224,263,789	252,503,651
New Mexico	5,368,666	5,334,192	7,099,842	10,140,140	4,991,351
Nevada		413,292	1,090,635	1,998,164	12,241,372
Oregon		846,615	545,859	518,694	271,191
South Dakota	[b] 100,000	38			5,471
Utah	47,062,889	54,083,506	50,329,119	66,418,370	71,370,370
Washington	663,694	223,328	290,823	122,263	162,201
Wyoming	3,565,629	2,530,531	106,177	3,026,004	2,416,197
Eastern States	15,211,086	15,134,192	21,438	696,102	143,002
Southern States			18,460,210	20,166,822	19,789,598
Middle States			54,347	[c] 1,299,043	[c] 1,580,831
Lead desilverizers and unapportioned	[b] 100,000				
	812,537,267	888,784,267	917,805,682	868,996,491	942,570,721

[a] For several of the early years the production credited to Colorado includes the yield from some ores of uncertain origin which were smelted in Colorado plants.
[b] Based partly on estimates.
[c] Includes "unapportioned."

TONNAGE AND YIELD OF COPPER ORES.

TONNAGE.

The following tables show the tonnage and yield of copper ores produced by the mines of the United States in 1908. The figures are taken from the mine reports of the various States, which form a part of the volume on Mineral Resources issued annually by the Geological Survey. As stated in a preceding section, a portion of this output was not smelted during the year; but the remarkably close agreement between the output as reported by the mines and the actual recovery of metal by the smelters, as already noted, leads to the belief that the tenor of ores as reported by the mines is very close to the actual recovery of metal. The classification of some of the complex western ores is a difficult and more or less arbitrary matter. Under copper ores [a] are classed those which contain 2½ per cent or more of copper, as well as those which contain less than this percentage, provided their principal value is in copper. Under copper-lead and copper-zinc ores are classed complex ores in which copper is an important constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for values in other metals. No attempt has been made to compile tables showing the tonnage and yield of this group of copper-bearing ores. They yielded a total of 11,253,776 pounds of copper, or a little over 1 per cent of the total output, and 16,696,550 pounds were recovered from old slags, smelter cleanings, etc., and precipitated from mine waters.

Copper produced in 1908 from ores in which copper constitutes the principal value, by States.

State.	Copper ore.	Copper in ore.	Percentage.	Gold in ore.	Silver in ore.	Value in gold and silver per ton.
	Short tons.	*Pounds.*		*Fine ounces.*	*Fine ounces.*	
Alaska	51,509	4,585,362	4.45	2,296.99	33,602	$1.27
Arizona	3,172,465	276,665,750	4.36	41,640.36	1,777,032	.54
California	513,414	38,743,131	3.77	22,885.83	1,031,381	1.99
Colorado	12,347	1,655,872	6.70	5,006.03	193,206	16.67
Idaho	107,400	9,975,814	4.64	8,152.32	631,261	4.6
Massachusetts and New Hampshire	3,710	188,756	2.54	177.25	6,270	1.88
Michigan	10,531,271	223,286,700	1.06	.....	241,055	.01
Montana	3,745,576	243,796,571	3.25	32,090.58	8,178,514	1.33
Nevada	434,887	15,282,385	1.76	4,629.58	29,321	.26
New Mexico	93,359	6,086,950	3.26	3,757.09	24,768	.97
North Carolina and South Carolina	37	5,949	8.04	3.00	151	3.87
Oregon	2,133	290,874	6.82	283.72	287	2.82
Tennessee	618,806	19,459,501	1.55	149.33	57,696	.05
Texas	139	28,364	10.20	.....	.....	.....
Utah	2,976,433	83,410,843	1.40	111,086.12	2,620,680	1.24
Virginia	1,896	23,600	.62	.....	93	.03
Washington	6,478	237,386	1.83	86.15	19,200	1.85
Wyoming	19,026	2,452,049	6.44	325.37	3,990	.46
	22,290,886	926,175,857	2.07	232,569.72	14,848,507	.56

[a] See report on Gold and silver.

Copper ores concentrated and smelted, concentrates produced, copper produced from each class of ore, in 1908, by States.

State.	Ores concentrated.	Concentrates produced.	Copper in concentrates.	Percentage of copper in ore.	Ores smelted.	Copper produced.	Percentage.
	Short tons.	*Short tons.*	*Pounds.*		*Short tons.*	*Pounds.*	
Alaska					51,509	4,585,362	4.45
Arizona	1,399,897	248,376	61,196,292	2.18	1,907,469	215,469,458	5.65
California					513,414	38,743,131	3.77
Colorado	200	25	8,000	2.00	12,147	1,647,872	6.79
Idaho					107,400	9,975,814	4.64
Massachusetts and New Hampshire					3,710	188,756	2.54
Michigan	10,531,271	169,616	223,286,700	1.06			
Montana	3,005,574	874,331	170,998,935	2.84	740,002	72,797,636	4.92
Nevada	433,500	38,689	14,830,439	1.71	1,387	451,946	16.29
New Mexico	53,868	3,750	3,817,298	3.54	39,490	2,269,652	2.88
North Carolina and South Carolina	19	1	1,600	4.21	18	4,349	14.1
Oregon					2,133	290,874	6.82
Tennessee					618,806	19,459,501	1.55
Texas					139	28,364	10.20
Utah	2,331,514	121,046	53,409,843	1.15	644,919	30,001,000	2.33
Virginia	1,896	77	23,000	.62			
Washington	2,783	461	3,765	.07	3,965	233,021	2.95
Wyoming					19,026	2,452,049	6.44
	17,760,522	1,456,372	527,576,472	1.485	4,665,534	398,599,385	4.27

Copper produced from copper-lead and copper-zinc ores in 1908, by States.

State.	Copper-lead and copper-zinc ores.	Copper in ore.	Percentage of copper in ore.
	Short tons.	*Pounds.*	
Arizona	84	6,900	4.10
California	368	10,803	1.46
Colorado	58,236	2,013,708	1.73
Idaho	15	799	2.66
Montana	297	23,981	4.03
Nevada	2,217	305,041	6.81
New Mexico	20	1,320	3.30
Utah	6,734	351,743	2.61
	67,971	2,714,295	1.99

Copper derived from ore classed as copper-bearing ores, and total production of copper from all sources, in 1908, by States.

State.	Total ores.			Copper from all sources, including old slags, smelter cleanings, precipitates, etc.
	Tons treated.	Pounds of copper recovered.	Percentage in ore.	
	Short tons.			*Pounds.*
Alaska	51,509	4,585,362	4.45	4,585,362
Arizona	3,172,549	276,672,650	4.36	[a] 285,858,133
California	513,782	38,753,934	3.77	[b] 38,776,881
Colorado	70,583	3,669,580	2.60	[c] 9,997,738
Idaho	107,415	9,976,613	4.65	10,041,850
Massachusetts and New Hampshire	3,710	188,756	2.54	188,756
Michigan	10,531,271	223,286,700	1.06	[d] 223,286,700
Montana	3,745,873	243,820,552	3.26	[e] 251,667,795
Nevada	437,104	15,587,426	1.78	15,598,788
New Mexico	93,379	6,088,270	3.26	[f] 6,112,630
North Carolina and South Carolina	37	5,949	8.04	[g] 20,993
Oregon	2,133	290,874	6.82	291,377
Tennessee	618,806	19,459,501	1.55	19,459,501
Texas	139	28,364	10.20	28,364
Utah	2,983,167	83,762,586	1.41	86,848,812
Virginia	1,896	23,600	0.60	[g] 24,775
Washington	6,478	237,386	1.83	312,030
Wyoming	19,026	2,452,049	6.44	2,452,049
Other States	.....	.....	.....	1,288,044
	22,358,857	928,890,152	2.08	956,840,578

[a] 9,153,307 pounds of copper were recovered from old slags and precipitated from mine waters. Some copper was also recovered from ores concentrated for other metals.
[b] A small quantity of copper was recovered from mine waters.
[c] A large percentage of the copper was derived from ores not classed as copper ores.
[d] Includes some copper derived from "mass" and "barrel" copper.
[e] Over 7,520,000 pounds of copper was recovered from old slags, etc., and precipitated from mine waters. Over 500,000 pounds was recovered from ores not classed as copper ores.
[f] Some copper was derived from gold and other ores.
[g] Some copper was recovered from pyrite cinders.

The output of copper, copper-lead, and copper-zinc ores mined in 1908 was 22,358,857 tons, as compared with 20,111,265[a] tons in 1907; of this output, 22,290,886 tons were copper ore and 67,971 tons were copper-lead and copper-zinc ores, as compared with 20,039,484 tons of copper ore and 71,781 tons of copper-lead and copper-zinc ores in 1907.

Of the total of 22,290,886 tons of copper ore, 4,665,534 tons were smelting ore and 17,760,522 tons were concentrating ores, as compared with 5,107,500 tons of smelting ore and 16,295,500 tons of concentrating ore in 1907. In 1908 copper concentrating ores produced 1,456,372 tons of concentrates, the average concentration being 10.8 into 1, as compared with nearly 9 into 1 for 1907. Excluding the ore and concentrates from Michigan, 7,229,251 tons of ore produced 1,286,756 tons of concentrates, or a concentration of about 5.6 into 1.

Michigan, with 10,531,271 tons, or over 47 per cent of the total tonnage, was by far the largest producer of copper ore. Montana produced nearly 16 per cent, followed by Arizona and Utah, in the order named, with about 13 per cent each. Next in order were Tennessee, California, and Nevada. Arizona was by far the largest producer of smelting ores, followed by Montana, Utah, Tennessee, and California. In concentrating ores, the producing States were in the following order: Michigan, Montana, Utah, Arizona, and Nevada.

[a] The figures for 1907 are for materials smelted; those for 1908 include some ore and concentrates that were not smelted at the close of the year.

YIELD.

The 22,358,857 tons of copper, copper-lead, and copper-zinc ores mined in 1908 yielded 928,890,152 pounds of copper, or 2.08 per cent as compared with 2.11 per cent in 1907. If the Michigan output is excluded, the yield of the remaining copper ores is 2.98 per cent for 1908, as compared with 3.10 per cent for 1907. In 1908 copper ores produced 926,175,857 pounds of copper, or 2.08 per cent, and copper-lead and copper-zinc ores yielded 2,714,295 pounds of copper, or 1.99 per cent.

The 4,665,534 tons of copper ore smelted yielded 398,599,385 pounds of copper, an average yield of 4.27 per cent copper, as compared with 4.05 per cent for 1907. The 17,760,522 tons of concentrating ore yielded 1.485 per cent in 1908, as compared with 1.41 per cent in 1907. Excluding the product from Michigan, which yielded 1.06 per cent in 1908 as compared with 1.10 per cent in 1907, the concentrating ores from the remainder of the United States yielded 2.10 per cent copper in 1908 as compared with 1.91 per cent in 1907.

Among the important copper-producing States, Arizona takes the lead in the yield of copper per ton of ore, the average for 1908 being 4.36 per cent. California is second with a yield of 3.77 per cent, and Montana is third with 3.25 per cent. Tennessee, Utah, and Michigan follow in the order named. Of the States producing an important tonnage of smelting ores, Arizona averages highest in copper per ton of ore, the average yield for the year being 5.65 per cent; Montana is second with a yield of 4.92 per cent; and California, Utah, and Tennessee follow, with yields of 3.77, 2.33, and 1.55 per cent, respectively. In the yield per ton of concentrating ores, Montana leads with an average of 2.84 per cent, followed by Arizona with 2.18 per cent; Nevada, 1.71 per cent; Utah, 1.15 per cent; and Michigan, with 1.01 per cent. The Virginia concentrates were produced largely from ores from which the richer portions had been hand sorted. The Washington concentrates were produced in a test run of low-grade ore.

In 1908 copper ores yielded 232,570 ounces of gold and 14,848,507 ounces of silver, or 0.0104 ounce of gold and 0.666 ounce of silver per ton, an average precious-metal value of 56 cents per ton. For 1907 copper ores produced 0.0135 ounce of gold and 0.609 ounce of silver per ton. Exclusive of the Michigan ores from which the silver was not recovered, about 8,475,000 tons in 1908, the average yield for the remaining ores was 0.0166 ounce of gold and 1.075 ounce of silver per ton, or a combined precious-metal value of 91 cents per ton of ore. For 1907 the yield, exclusive of Michigan ores that did not yield silver, was 0.022 ounce of gold and 1.15 ounces of silver per ton. In the latter figures there is included considerable ore from which the gold and silver were not recovered, namely, that contained in copper from the Clifton-Morenci district of Arizona, the Ducktown district of Tennessee, and to a less extent from other districts, which produced copper which was not electrolytically refined and from which, consequently, the precious metals were not recovered.

Among the important copper-producing States California was first in the value of gold and silver per ton of ore, the average for 1908 being $1.99; Montana followed with $1.33 per ton; Utah averaged $1.24 per ton; Arizona, $0.54; Nevada, $0.26; Tennessee, $0.05; and Michigan, $0.01.

REVIEW BY STATES.

In the following pages a brief statement of the conditions affecting production in the principal districts of the country is presented, the geological occurrence of the ores is briefly summarized, and the tenor of ore from each district is given when this will not disclose the production of individual companies, the figures of whose output have not already been published in their annual report or elsewhere.

Those desiring more detailed information of the mining operations of the districts are referred to the reports on mine production for the various States, which have been published by the United States Geological Survey and which, with this and other reports, form the first part of the volume Mineral Resources of the United States for 1908.

ALASKA.

The blister-copper production for Alaska in 1908 was 4,438,836 pounds, as compared with 7,034,763 pounds in 1907. This marked decrease was due to the fact that the Alaska producers had not recovered from the unfavorable conditions which prevailed in the latter part of 1907, and some of the mines were unable to produce copper at the price that prevailed for 1908. The production, as in previous years, was from the Ketchikan and Prince William Sound districts.

Ketchikan district.—The Ketchikan region was by far the larger producer, yielding over 3,000,000 pounds of copper. The deposits of this district[a] thus far developed are of contact origin. The ores run high in iron, being composed of pyrrhotite, magnetite, pyrite, and chalcopyrite. A part of the ore was treated at the Hadley smelter of the Alaska Mines Security Company, which was operated from September 5 to November 15, and the remainder was shipped to the Tacoma smelter. Only the relatively high-grade ore is treated at present. The ore carries rather low gold and silver values.

Prince William Sound district.—Most of the shipments from this district were from 2 mines on Latouche Island, though small shipments were made by several other properties. Only the high grade of ore can be profitably shipped from these mines under present conditions. The ores[b] are pyrrhotite, chalcopyrite, and pyrite, occurring in shear zones in or closely associated with greenstone.

Copper River district.—During 1908 the railroad was completed from Cordova to Child's Glacier. This connects with steamers on the Copper and Chitina rivers and furnishes easy access to the Copper River district. Thus far only one property—the Bonanza mine of the Kennicott Mines Company, said to be controlled by the Guggenheim interests, has proved to be of commercial importance. This deposit is situated at the head of Bonanza Creek, near Kennicott Glacier. The ores[c] are chalcocite and azurite in limestone. The ores are extremely rich, and a large tonnage is in sight, though the extent of the deposit has not been determined. No production has yet been made from this district and none is likely before 1910.

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[a] For detailed descriptions see Wright, C. W., and Paige, S., Bull. U. S. Geol. Survey No. 345, 1908, pp. 98–115; and Wright, F. E., and Wright, C. W., Bull. U. S. Geol. Survey No. 347, 1908.

[b] Grant, U. S., Bull. U. S. Geol. Survey No. 284, 1906, pp. 78–87; Moffit, F. H., Bull. U. S. Geol. Survey No. 345, 1908, pp. 176–178; Grant and Higgins, Bull. U. S. Geol. Survey No. 379, 1909, pp, 87–96.

[c] Moffit, F. H., and Maddren, A. G., Bull. U. S. Geol. Survey No. 345, 1908, pp. 127–175.

ARIZONA.

In 1908 Arizona produced 289,523,267 pounds of blister copper, as compared with 256,778,437 pounds in 1907 and 262,556,103 pounds in 1906, thus making a new record for the Territory and maintaining its rank as first among the copper-producing States, a position which it gained in 1907.

Many of the smaller properties of the Territory were not active during the year, owing to inability to recover from the depression of 1907, but the large producers increased their output more than to counterbalance this loss. The greater part of the production was from four districts.

Bisbee district.—The Bisbee or Warren district, located in southern Cochise County, was the largest producer, with nearly 129,000,000 pounds of blister copper, as compared with 110,000,000 pounds in 1906.

The ore bodies[a] replace Carboniferous limestone and are closely associated with intrusions of granite porphyry. The presence of amphibole, pyroxene, garnet, vesuvianite, etc., associated with the ores indicate contact metamorphic origin.

The primary ore is largely cupriferous pyrite, but the workable ore bodies thus far developed have resulted from a concentration of the copper contained in these primary ores by the process known as "secondary enrichment." Under favorable conditions this has extended to great depths, resulting in an extensive zone in which kernels of the primary ore are surrounded by secondary sulphides. In the upper part of the deposits the ores are carbonates, oxides, and native copper. In some cases iron gossans at the surface indicate the presence of underlying ore bodies, though in many instances ore bodies have been developed where there were no surface indications to point to their presence. In the early days of the Copper Queen mine, the copper produced was practically all from oxidized ores carrying above 20 per cent copper. With the improvement in metallurgical treatment, lower-grade ores have been more extensively treated, and of late years the percentage of copper derived from sulphides has been steadily increasing, till at present it probably nearly equals that derived from oxidized ores. During 1908 bodies of sulphide of smelting grade were developed in the lower workings of the Calumet and Arizona and the Superior and Pittsburg mines. Oxidized ore has been developed in the Lowell mine of the Copper Queen Company, and also sulphide bodies, at a depth of 1,400 feet, and oxidized ores have been encountered on the 1,350-foot level of the Hoatson shaft of the Superior and Pittsburg mines.

At the present time the grade of ore to be mined is a matter to be determined by the possibility of profitable treatment. During 1908 the average copper content of ores for the district was between 6 and 7 per cent. The annual reports of the Calumet and Arizona and the Superior and Pittsburg companies show that the copper content of ores treated for the year as taken from the mine was, respectively, 4.68 and 4.38. The gold and silver content per ton of refined copper for the same companies was, respectively, $16.72 and $11.06

[a] For detailed geological report see Ransome, F. L., Prof. Paper, U. S. Geol. Survey, No. 21, 1904.

Development is carried on by means of vertical shafts, and the square set and filling system is mainly employed in the mines. The timber charge is an important item in the cost of extraction of the ores.

The production in 1908 was principally from the Copper Queen, the Calumet and Arizona, and the Superior and Pittsburg mines. The Shattuck-Arizona mine also contributed to the output of the year.

During the year the Copper Queen installed a new system of handling ore. This consists of an electric haulage system underground, the hoisting of all the ore in skips through the Sacramento shaft, and a belt-conveyer system for loading the cars at the surface.

Improvements were made in the smelting plants at Douglas of both the Copper Queen and the Calumet and Arizona, the latter company adding a new furnace to its plant and largely increasing its smelting capacity. The district is served by the El Paso and Southwestern Railroad, controlled by Phelps, Dodge & Co. Both coal and oil are used as fuel for the production of power.

Jerome district.—The Jerome district of Yavapai County produced about 36,000,000 pounds of blister copper in 1908, as compared with 33,000,000 pounds in 1907 and 38,000,000 in 1906.

The following description of the principal mine in the Jerome district is quoted from L. C. Graton:[a]

The United Verde ore body occupies a zone of shearing so intense that the containing rock, a rather basic porphyry, has here been converted into a schist. Pyrite, chalcopyrite, and some zinc blende, with varying amounts of quartz, have in places partially or completely replaced this schist, and in other places the schist is injected by veinlets and stringers of sulphides and others of quartz. As a rule the more massive sulphide ore contains more iron and zinc, while that consisting of alternating bands of sulphide and schist—the so-called "slaty" ore—carries a much higher proportion of chalcopyrite. The ores are undoubtedly of pre-Cambrian age, like the inclosing rocks, and are wholly independent of the Devonian sediments which almost overlie the deposit. Almost the entire output in 1907 came from sulphide ores, but a little oxidized ore, rather high in gold, added to the production. The ores mined are all of smelting grade and carry a high percentage of copper, the average yield in 1907 having been considerably above that of the Bisbee camp and much higher than that of the other large pyritic deposits of Bingham, Utah; Shasta County, Cal.; and Ducktown, Tenn. The content of the ores in gold and silver is decidedly higher than in any other of the large Arizona copper camps and far above the precious-metal yield of the pyrrhotite ores of Ducktown, although not very different from that of the Bingham and Shasta County ores.

So far as present developments have shown, the ore body is an irregular, rudely lenticular mass of large dimensions. The surface outcrop of the lens was about 800 feet long. The shoot pitches northward and undoubtedly extends along the pitch beyond and below the region explored to date.

Extraction is effected through shafts, although there is a tunnel reaching the 500-foot level, and a new tunnel is being driven in to strike the lowest level of the new 1,000-foot shaft. Motor haulage is used on the principal levels. Square setting is employed only where absolutely necessary, and the use of timber is avoided as much as possible, owing to danger from fires. Native round timber is the kind most used. The system now prevailing is overhead stoping with horizontal back, and filling kept up within working distance. Work is carried on in certain portions of the "fire country" by the employment of the plenum air-pressure system originated at Iron Mountain, Cal. The developed workings are not very wet, but considerable surface water finds its way into the mine through the caved ground, and, passing through the burning stopes, takes up copper and sulphuric acid. An extensive system of flumes allows the precipitation of most of this copper. The district is served by a narrow-gage line owned by the company, which connects with the Santa Fe, Prescott and Phoenix Railway. Oil is the principal fuel. European labor is extensively employed, but the wages are high, the daily pay for work in the "fire country" being $4.

[a] Graton, L. C., Mineral Resources U. S. for 1907, pt. 1, U. S. Geol. Survey, 1908, p. 597.

All the higher sulphur ores are roasted before smelting, the claim being made that the ores carry too high alumina to make pyritic smelting successful. The highest grade ores are lower in sulphur and are smelted direct. It is an interesting fact that ore extracted from stopes which had been on fire for several years is oxidized only slightly, and not at all except along fractures. Limestone flux is quarried along the railroad near the mine. Siliceous material is encountered in the workings in sufficient quantity to supply converter lining. The coke, which averages 10 per cent of the charge, is from Colorado. The settling of the ground under and around the smelter appears to have ceased, and a new 20-foot furnace was added in 1907.

The ground considered as ore reserves in 1902 was lost to immediate availability by the fire and the attendant caving. These stopes are now gradually being reclaimed, but most of the ore now being mined comes from stopes that were unknown three years ago.

Several companies in the Jerome district were engaged in exploration in 1908, but no important deposits have yet been developed.

Clifton-Morenci district.—The deposits of this district are at Morenci and Metcalf, in the eastern part of Graham County. During 1908 the district produced nearly 77,000,000 pounds of blister copper as compared with 63,000,000 pounds in 1907.

The copper ores[a] of this district occur as contact deposits in Paleozoic limestones and shales which have been intruded by stocks and dikes of porphyry, and as disseminated deposits mainly in the porphyry.

The original ores in both types were pyrite and chalcopyrite of too low grade to be of economic importance. The workable bodies have resulted from the process of secondary enrichment. The ore bodies in the lime were formed in certain beds favorable to deposition and this produced roughly tabular bodies nearly parallel to the stratification of the lime. Alteration of these bodies has produced carbonates which formed most of the workable ores in the limestone. These are now nearly exhausted.

The disseminated ores occur in highly altered porphyry adjacent to fissure veins. The copper content of the upper portion of these deposits has been leached and deposited on the pyrite lower down as chalcocite. This has produced a zone of commercial ores, varying in thickness, but usually not extending below a depth of 400 feet. The Coronado mine, which is in a fault fissure, has been developed to a much greater depth. The greater portion of the copper of the district is derived from concentrating ores containing chalcocite in altered porphyry.

For 1908, the yield of copper from concentrating ores was about 2.2 per cent, and from smelting ores a little over 4 per cent. About 72 per cent of the copper is derived from concentrating ores. The precious-metal content is so low that for much of the output of the district it is not found profitable to refine the product electrolytically to recover this content if the copper is otherwise sufficiently pure to be put on the market.

The fact that the region is one of considerable relief and that the workable copper deposits in general are in the higher ground permits the opening of most of the deposits by tunnels and insures a practical freedom from water in the mines.

The smelters handled during 1908 about 258,000 tons of smelting ore and 208,000 tons of concentrate, representing about 1,528,976

[a] For detailed report of the Clifton-Morenci district, see Lindgren, W., Prof. Paper U. S. Geol. Survey No. 43, 1905.

tons of ore mined. The district is served by the Arizona and New Mexico Railroad, owned by the Arizona Copper Company.

Globe district.—The Globe district of Gila County produced about 36,000,000 pounds of blister copper in 1908 as compared with 35,000,000 in 1907. The output, as in previous years, was derived largely from the Old Dominion and the United Globe mines.

The ore[a] deposits occur as roughly lenticular replacement bodies in limestone and fault lodes or fissure zones in the diabase. The ore that has been thus far extracted from the limestone deposits has been largely oxidized while much of the ore in the diabase is enriched sulphides. This enrichment, under favorable conditions, has extended at least to the sixteenth level, 1,200 feet below the surface. In the United Globe some bodies of primary sulphide ores of commercial grade have been developed. In the early days of the district practically all the copper was derived from oxidized ores, but the percentage of sulphide ore has gradually increased till at present it is more important than the oxides, about 70 per cent of the copper recovered from ores mined during the year 1908 being from sulphur-bearing ores, and this will probably soon be the main ore of the district. The ores vary greatly in richness, and the copper content of ores treated is largely controlled by conditions that permit of profitable working of the lower grade ores. During 1908 the ores yielded about 4½ per cent copper. A little over one-third of the ores were concentrated in the proportion of about 3 into 1. The gold and silver content of the ores are low, the average yield for the year being about 0.4 cents per pound of copper.

During the last two years large deposits of low-grade disseminated secondary sulphide ore have been developed in the Miami district, about 6 miles west of Globe. On the Miami property, which is the most extensively developed, the ore body has been opened on the 270-foot, 370-foot, and 470-foot levels, and is being developed on the 570-foot level. In the upper levels the ore carries about 3 per cent copper, but on the lowest level it is reported to have dropped to about 2½ per cent. According to statements by the management 13,000,000 tons of ore were developed by June 1, 1909. A railroad is being built from Globe to the district, and a concentrating mill is under construction by the Miami Copper Company.

During the year the Old Dominion plant treated ores from California, from the Copper Queen and other Arizona mines, and from Cananea (Mexico). The district is served by the Gila Valley, Globe and Northern Railway, a branch of the Southern Pacific.

Silverbell district.—During the year the Southern Arizona Smelting Company erected a second furnace and greatly increased the capacity of its smelter at Sasco. The plant began operations February 1, 1908, and a second blast furnace was blown in November 1, 1908. The ores of the district occur in altered limestone associated with porphyry intrusives. The district produced about 6,700,000 pounds of blister copper in 1908. The ores yield about 3 per cent copper with low precious metal values.

Other districts.—Most of the smaller smelters of the Territory were closed during the year, and consequently the districts depending on these showed little production during 1908.

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[a] For detailed account see Ransome, F. L., Prof. Paper U. S. Geol. Survey No. 12, 1902.

Development work continued in the Mineral Creek district of Pinal County, being especially active during the latter part of the year. The Ray Consolidated Copper Company has a large body of low-grade disseminated chalcocite ore, estimated by the management early in 1908 to be 20,000,000 tons, blocked out. The ore is reported to average about 2½ per cent. The property is being extensively prospected by means of churn drills.

The Courtland district of Cochise County, 35 miles northeast of Bisbee, is a new district that may prove to be a large producer. During the year, the Copper Queen, the Calumet and Arizona, and the Great Western Copper companies have done considerable development work with encouraging results. The ore, which is oxidized, occurs as replacement along fractures in limestone and also, to some extent, in altered limestone close to intrusive areas. Branch lines connect the camp with Douglas and the Southern Pacific, and the district will probably produce considerable ore before the close of 1909.

The building of the Arizona and California Railroad from Wickenburg to Parker has opened up a new territory in southern Mohave and northern Yuma counties. There was considerable activity in the district during 1908, especially at Bouse.

The Humboldt smelter of the Consolidated Arizona Smelting Company, Yavapai County; the matte smelter of the Saddle Mountain Company, at Christmas, Gila County; the Helvetia Copper Company, at Helvetia, Pima County; and the Duquesne Mining and Reduction Company, at Duquesne, Santa Cruz County, were all idle, and in consequence the districts dependent on these plants showed little activity.

CALIFORNIA.

The production of blister copper in California for 1908 was 39,643,835 pounds, as compared with 33,696,602 pounds for 1907, an increase of 5,947,233 pounds. The production, as in previous years, was largely from the Shasta County belt, and most of the increase is credited to that district.

Shasta district.—The Shasta County belt is situated in the Klamath Mountains, at the head of the Sacramento Valley, a few miles north of Redding. The Sacramento River crosses the belt, separating it into eastern and western portions. The eastern portion contains the Bully Hill and the Afterthought districts, and the western, the Iron Mountain and the Little Backbone districts.

The district produced about 32,500,000 pounds of blister copper in 1908, as compared with about 28,000,000 in 1907.

In the early days the gossan croppings were worked for precious metals, but it was not until 1897 that the district assumed importance as a copper producer.

The country rock[a] is a soda granite porphyry intrusion of probable late Triassic age. The ore bodies have replaced this rock along zones of shearing. In the western district the ores thus far developed are large, flat lying, more or less tabular, bodies of no great vertical extent. In the eastern district they have more the character of veins and, locally, form deposits in the adjoining sediments. The ore in the western dis-

[a] Diller, J. S., Redding folio (No. 138), Geol. Atlas U. S., U. S. Geol. Survey, 1906; Bull. U. S. Geol. Survey No. 213, 1903, pp. 123–132; Bull. U. S. Geol. Survey No. 225, 1904, pp. 169–179. A report based on detailed investigations of the ore deposits is now in course of preparation by the Survey.

trict is pyrite, with a small percentage of chalcopyrite; in the eastern district sphalerite becomes an important constituent.

Rich secondary sulphide ores were found underlying the gossan at Iron Mountain and Bully Hill, but these have been exhausted.

The ores carry values in precious metals, those of the eastern district being rich in them. The average metal content of ores smelted in the district for 1908 was 3.2 per cent of copper, with $1.86 in gold and 1.88 ounces of silver, valued at $0.996 per ton. The combined precious metal content is equivalent to 4.4 cents per pound of copper. A large tonnage of ore is blocked out in the mines of the district.

The producing companies in 1908 were the Mountain Copper, Balaklala, Trinity, Mammoth, and Bully Hill companies. The Great Western Gold Company's property at Ingot was not operated during 1908. All of the ore is smelted in the district, except that of the Mountain Copper Company, which during 1908 was treated at its Martinez plant on San Francisco Bay.[a] In addition to local ores, the smelters treated ores from Nevada, Utah, and Oregon. A large tonnage of the low-grade gold quartz ores of the district was used by the smelters of the western district to flux their ores. Pyrite smelting is successfully practiced throughout the belt. In the eastern district hot blast is used in the smelting of ores which are high in zinc.

Three smelters were operated in the district during 1908: The Mammoth smelter of the Mammoth Copper Mining Company at Kennett, the Bully Hill smelter of the Bully Hill Copper Mining and Smelting Company at De Lamar, and the Balaklala smelter of the First National Copper Company at Coram. During the latter part of the year the Mountain Copper Company operated its McDougal roasters, treating the fines from the mines before shipment to the Martinez plant.

The Mammoth plant was operated throughout the year. The original plant was enlarged during 1907 by the addition of 2 new blast furnaces, a converting plant with 2 converter stands and 8 shells, and of other improvements. The Bully Hill smelter, which has been rebuilt during the last two years, was again blown in in April, 1908. The plant consists of 2 blast furnaces and a reverberatory with McDougal roasters. The converter plant has not been rebuilt. During 1908 the matte was converted at the Mammoth smelter. The new Balaklala smelter, which was blown in in October, has 3 blast furnaces and a reverberatory with McDougal roasters, and 2 converter stands with 6 shells. The converters were operated only a few days at the close of the year, and only a small portion of the matte produced was converted in 1908. During the year 464,105 tons of ore were treated at the smelters in this district. With the existing plants in full operation the district will show a marked increase in output in 1909.

Electric power is used almost exclusively at both mines and smelters. Much of the coke for smelting comes from Australia. The district is served by the Southern Pacific Railroad, short branches extending to the smelters. Early in 1908 the Sacramento Valley and Northern Railroad was completed to the Bully Hill district. A line is projected from Bellavista to the Afterthought district.

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[a] Previous to 1906 the company smelted its ores at Keswick, but discontinued operating the plant on account of smelter smoke suits brought against it by the farmers and the Government. During the year the government suit against the company was dismissed.

Other districts.—The only other district making an important production in 1908 was that known as the "Foothill Copper Belt," whose greatest development is in Calaveras County. The ores,[a] consisting of pyrite with chalcopyrite, occur as lenticular bodies in schist. The ores vary in different parts of the district from those carrying nearly pure pyrite and chalcopyrite with very low gold and silver content to ores carrying considerable lead, zinc, and precious metal. The ores treated in the district during 1908 averaged about 4 per cent in copper, with nearly 3 cents in precious metal per pound of copper.

In addition to the ores treated in the local smelters, California ores were treated in Washington, Arizona, and Utah.

COLORADO.

In 1908 Colorado produced 13,943,878 pounds of blister copper as compared with 13,998,496 pounds in 1907. The great difference between reported mine production and smelter yield, as noted in this and previous reports, is probably due very largely to the fact that much of the copper is recovered from ores treated primarily for other metals. In some of these ores the copper content is so low that it is not paid for by the smelters and consequently is not reported by the mines. This copper, however, is eventually recovered and appears in the smelter output.

Although the State makes a considerable output of copper, it contains no large producing district in which copper is the principal metal, most of the production being incidental to the recovery of other metals. This accounts for the fact that the reduction in the price of copper which occurred in 1907 and continued through 1908 did not materially affect the output of Colorado, while other States whose output was derived from small copper camps showed marked reduction.

The largest production, as in previous years, was from Lake County, and from San Juan, Gilpin, Chaffee, and Clear Creek counties; Ouray, Hinsdale, and San Miguel counties also contributed to the copper output. The districts in which copper is the most important metal are Cashin,[b] in Montrose County; southern Chaffee County;[c] and the plateau regions of southwestern Colorado.[d] None of these districts, however, made important productions in 1908.

Most of the copper was recovered in matte in the lead furnaces of the American Smelting and Refining Company's plants, though a considerable production was made by the Ohio and Colorado Smelting Company, at Salida, and the Boston and Colorado Smelting Company, near Denver. Considerable copper was also recovered by companies treating zinc ores from the State.

IDAHO.

During 1908 Idaho produced 7,256,086 pounds of blister copper as compared with 9,707,299 pounds in 1907.

The Coeur d'Alene district furnished most of the copper output for 1908, the greater part of it coming from the Snowstorm mine. This

[a] Knopf, A., Bull. Dept. Geology Univ. California, vol. 4, p. 411; Read, J. A., Econ. Geology, vol. 2, 1907, p. 380; Lang, Herbert, Eng. and Min. Jour., vol. 84, 1907, p. 909.
[b] Emmons, W. H., Bull. U. S. Geol. Survey No. 285, 1906, pp. 125–128.
[c] Lindgren, W., Bull. U. S. Geol. Survey No. 340, 1908, pp. 158–167.
[d] Emmons, S. F., Bull. U. S. Geol. Survey No. 260, 1905, pp. 221–232.

deposit[a] consists of disseminated bornite, chalcocite, and chalcopyrite in certain beds of a pre-Cambrian quartzite; in the upper portion the deposit is oxidized. The lode varies from a few feet to 40 feet in width, and has been developed to a depth of 1,200 feet below the outcrop. Development is by tunnels, No. 1 cutting the deposit about 200 feet below the outcrop, No. 2 at 500 feet, and No. 3, at 1,200 feet. No. 4 tunnel is planned to cut the ore body at a depth of 1,800 feet below the outcrop. The ore, being highly siliceous, is well adapted for converter linings and consequently receives favorable smelting rates. The shipping ore yields 4 to 4.5 per cent copper with about 6 ounces of silver and a little gold per ton. A leaching plant was erected for treating the low-grade oxidized ores, but this was not operated during 1908.

The smelter of the Empire Copper Company at Mackay was not operated during 1908, and the plant of the Lost Packer Company at Ivers, Custer County, was in operation but a few months.

The Idaho Smelting and Refining Company (formerly Panhandle Smelting Company) operated its plant the latter part of the year and produced a little copper matte in its lead furnaces.

MICHIGAN.

The smelter production of copper in Michigan in 1908 was 222,289,584 pounds, as compared with 219,131,503 pounds in 1907. In contrast to the two preceding years the smelter production was slightly smaller than the mine production, owing to the fact that a small amount of "mineral" produced by the mines was not smelted. During the two previous years the smelter production exceeded the mine production because of the fact that some "mineral" that had been stored during previous years was called out by the unusually high price of copper. The entire production comes from the Keweenaw Peninsula, which embraces parts of Houghton, Keweenaw, and Ontonagon counties.

Lake Superior region.—The Lake Superior region is unique in being the only district from which a large output is derived from native copper. The rocks[b] of the district comprise a thick series of basic lava flows and intercalated beds of conglomerate and sandstone of pre-Cambrian age. These have been tilted so that they have a northwest dip, usually rather steep, and strike in a general northeast-southwest direction. The copper occurs in the cellular portion of the lava flows, which form the amygdaloid lodes, and as a cement and to some extent a replacement of the conglomerate pebbles forming the conglomerate lodes. Copper also occurs in fissures crossing the formations, but at present these are of little commercial importance, though in the early days of the district considerable copper was derived from this type of deposit. A little native silver occurs with the copper. The lodes are of low grade but characterized by great extent and rather uniform distribution of the metallic content. This together with the fact that the ore is susceptible of high concentration with low cost of refining the resultant "mineral" makes it possible to work these low-grade deposits at a good profit. The native copper

[a] Ransome, F. L., Prof. Paper U. S. Geol. Survey No. 62, 1908, pp. 150–152.

[b] For detailed description of the Keweenaw series, see Irving, R. D., Mon. U. S. Geol. Survey, vol. 5; Geol. Survey Michigan, vols. 5 and 6; Rickard, Eng. and Min. Jour., vol. 88.

occurs in the lodes in masses varying from microscopic size to bodies weighing hundreds of tons. The richest lode mined at present carries less than 2 per cent copper, while the poorest rock treated yields but little above five-tenths of 1 per cent of metal. For this low-grade ore to be profitable it must be handled on a large scale; this has resulted in the construction of the immense plants that characterize the lake district. The lodes are worked for the most part through inclined shafts, though some of the deeper deposits are opened by vertical shafts. The workings have been extended in some cases to more than a mile in vertical depth, or about a mile and a half down the lode. Pillars of rock are left to keep the lodes open, and dry walls constructed from the waste sorted underground serve the same purpose. Much timber, however, is required in some of the mines, especially those operating on the conglomerate lodes.

The rock coming from the mines is crushed by steam stamps and concentrated, producing "mineral" containing an average of about 65 per cent copper. This is subjected to a combined smelting and refining process. A small amount of "mass" and "barrel work" copper are sorted out at the mine and go direct to the smelter. A portion of the output is electrolytically refined; this portion consists of copper sufficiently argentiferous to make the recovery of silver profitable and of copper containing so high a percentage of impurities that further refining is necessary for certain uses. During 1908 slightly over 12 per cent of the output was electrolytically refined. A demand for copper carrying arsenic that has recently arisen resulted in a great decrease in the amount treated to free it from this impurity.

The average recovery of silver per ton of rock mined was 0.023 ounce, a small portion being "pickings." The recovery per pound of copper electrolytically treated was 0.009 ounce, or slightly under one-half cent per pound.

The production of individual mines for 1907 and 1908 is shown in the following table; the last five are grouped in order that figures that have not already been published by the companies shall not be disclosed:

Smelter production of copper in Michigan in 1907 and 1908, by companies, in pounds.

Company.	1907.	1908.
Adventure	1,244,874	90,870
Allouez	2,934,116	3,047,051
Baltic	16,704,868	17,724,854
Centennial	2,373,572	2,196,377
Champion	16,489,436	17,786,763
Franklin	4,401,248	3,707,518
Isle Royale	2,667,608	3,011,664
Mass	2,078,677	1,766,930
Michigan	2,665,404	3,000,206
Mohawk	10,107,266	10,295,881
Osceola	14,134,753	21,250,794
Quincy	19,796,058	20,600,361
Tamarack	11,078,604	12,806,127
Trimountain	8,190,711	6,034,908
Victoria	1,207,337	1,290,040
Winona	1,285,863	.....
Wolverine	9,272,351	9,555,233
Ahmeek, Arnold, Calumet and Hecla, Lake Keweenaw[a]	92,498,759	88,124,007
	219,131,505	222,289,584

[a] Did not produce in 1907.

The average copper yield per ton of rock milled during 1908 was 21.1 pounds, as compared with 22 pounds for 1907. This brings the average for the district very nearly down to 1 per cent. The average copper recovery from conglomerate rock for 1908 was about 31 pounds per ton and for amygdaloid 17.6 pounds per ton. The copper derived from the two types, respectively, was about 40 and 60 per cent.

During 1908 the rock milled amounted to 10,502,606 tons, as compared with 9,892,214 tons for 1907, an increase of 610,392 tons.

The change in grade of ore handled by the Lake companies is shown in the following table. The figures published for individual companies have already appeared in their annual reports or elsewhere.

Tonnage and yield of ore milled by principal Michigan companies in 1906, 1907, and 1908.

Company.	1906.		1907.		1908.	
	Tonnage.	Yield per ton.	Tonnage.	Yield per ton.	Tonnage.	Yield per ton.
	Short tons.	*Pounds.*	*Short tons.*	*Pounds.*	*Short tons.*	*Pounds.*
Allouez	178,400	19.54	214,720	13.66	220,905	13.79
Baltic	649,932	22.15	761,288	21.94	764,117	23.20
Centennial	166,000	13.58	200,040	11.86	169,693	12.94
Champion	671,785	25.2	708,685	23.27	794,703	22.39
Franklin	372,378	12.27	383,290	11.48	342,596	10.82
Isle Royale	192,210	15.3	175,450	15.2	218,940	13.75
Mass	185,789	11.3	204,599	10.16	171,268	10.31
Michigan	140,225	20.4	150,407	17.72	190,548	15.74
Mohawk	618,534	15.12	640,777	15.77	685,823	15.01
Osceola	1,016,240	18.3	811,603	17.4	1,241,400	17.11
Tamarack	389,680	25.2	532,400	20.8	654,897	19.55
Trimountain	506,924	18.76	444,358	18.43	334,929	18.02
Wolverine	352,890	27.06	340,613	27.22	360,055	26.54
Adventure, Ahmeek, Calumet and Hecla, and Quincy	3,344,641	32.6	4,125,618	27.0	4,264,217	25.47

As shown by this table, the change in the grade of ore was much less between 1907 and 1908 than between 1906 and 1907.

The district is well located for cheap working of the mines. The Great Lakes furnish cheap transportation for both coal and copper, the lake transportation being brought into the heart of the district by Portage Lake and the Houghton Ship Canal. The district is served by the Mineral Range, Copper Range, and Keweenaw Central railroads, and is connected with the main lines of traffic by the Chicago, Milwaukee and St. Paul and South Shore and Atlantic railroads.

An event of importance occurring early in 1909 was the purchase by the Calumet and Hecla Company of the Bigelow holdings in the Osceola, Tamarack, Ahmeek, Seneca, and Isle Royale properties. This is an event of more than local interest, as, on the expiration of existing contracts, it will materially increase the copper controlled by the Calumet and Hecla selling agency.

MONTANA.

The output of blister copper for Montana in 1908 was 252,503,651 pounds as compared with 224,263,789 pounds in 1907, an increase of 28,239,862 pounds in spite of the fact that the Washoe and Great Falls smelters were idle for several months during the year.

Butte district.—The Butte district in Silver Bow County furnished practically the entire output. The copper ores[a] occur as replacement veins in a granitic rock, technically termed a quartz monzonite, which is greatly shattered and altered in the vicinity of the deposits. A shattering of the veins has permitted the free circulation of surface waters and produced the most remarkable example of sulphide enrichment known to mining geology. The original mineralization produced deposits of cupriferous pyrite. The copper content of the upper portion of these veins has been leached out and redeposited on the pyrite lower down, thus forming the bodies of chalcocite ore that have made the district famous. Where fracturing has produced favorable conditions this enrichment has gone to great depths, deposits of chalcocite or copper glance being found at 2,600 feet.

The ores as mined consist of chalcocite-pyrite-quartz smelting ores and altered granite impregnated with chalcocite and pyrite which requires concentration. In the early days of copper mining in the district nearly the entire output came from chalcocite, but of late years the output derived from enargite has been constantly increasing.

The copper content of the ores mined is regulated to some extent by the price of copper, the low-grade ores being mined when the price of copper will justify it. In 1906, the average yield from ores was 3.15 per cent; in 1907, with copper selling at a high price for a portion of the year, the yield was approximately 2.75 per cent; in 1908 it rose to 3.3 per cent. In 1908 smelting ores averaging 5.2 per cent copper furnished about 30 per cent of the output derived from ores, and concentrating ores, averaging 2.8 per cent, furnished about 70 per cent. In 1908 the ores averaged 2.1650 ounces of silver per ton and 0.0075 ounce of gold, the precious metals reducing the cost of copper about 2.3 cents per pound. Considerable copper was also recovered from mine waters and from old dumps and slags.

Development by the old companies has extended the ore reserves considerably, and the district is said to have as much ore developed now as at any period in its history. The Washoe smelter was closed from January 1 to March 15, owing to the unfavorable condition of the copper market, but for the latter part of the year maintained its normal output. The Great Falls plant of the Boston and Montana Company, which was operated at full capacity during the period of depression early in 1908, was so seriously injured by floods early in June that it was closed and was not restored to full operation until late October. During the year, the smelter of the Pittsburg and Montana Copper Company was rebuilt and a 200-ton blast furnace and standard converters added, giving the plant a smelting capacity of 400 tons. A 250-ton concentrating plant was also built by this company during the summer of 1908. The Butte Reduction Works, controlled by W. A. Clark, and the mines upon which it depends for ore were operated throughout the year.

The district is served by three trunk lines of railroad, and a private standard gage line connects the mines with the Washoe smelter at Anaconda. Much of the timber used in the district comes from the extensive timber lands controlled by the Amalgamated Company. Coal is also largely derived from the mines owned by this company in

[a] Weed, W. H., Bull. U. S. Geol. Survey No. 285, p. 112. A detailed report on the district will soon be published by the Survey.

Montana and Wyoming. For power purposes electric power derived from the Missouri River and other streams has largely replaced steam power. American labor is largely employed and wages are high, but vary with the price of copper according to an agreement entered into between the companies and the miners' union.

During the year, the district smelters treated about 1,791,000 tons of ore and concentrates, of which about 667,000 tons were treated without concentration. In addition to ore and concentrates, about 84,000 tons of smelter cleanings, etc., were treated.

NEVADA.

The production of blister copper in Nevada in 1908 was 12,241,372 pounds, as compared with 1,998,164 pounds in 1907. The marked increase is due to the beginning of production by the companies in the Ely district, White Pine County.

Ely district.—The Ely district is located in central White Pine County, in the Egan range. This range has been described by Prof. A. C. Lawson[a] as composed of Paleozoic limestones and shales, in which igneous rocks form intrusives and flows. The copper deposits thus far extensively developed occur as disseminations in highly altered porphyry intruded into the Carboniferous sediments. Deposits occur at the contact of intrusive with limestone, but thus far these have not been shown to be of great economic importance. The upper part of the porphyry deposits have been oxidized and leached of their copper values, which have gone to enrich a lower zone. This is characterized by pyrite and chalcopyrite, and by chalcocite, which more or less completely replaces pyrite.

The developed mines are those of the Nevada Consolidated, the Cumberland-Ely, and the Giroux Consolidated companies. Development on other properties is in progress, and some ore has been proved. A large tonnage of ore has been developed in the district, for the most part within a few hundred feet of the surface.

During 1908 production was made by the Nevada Consolidated Company, at Copper Flat, by the Veteran Mine of the Cumberland-Ely Company and by the Giroux Consolidated Company. At Copper Flat the leached overburden is removed and the ore is mined with steam shovels. At the other mines, where the overburden is considerably thicker, the caving system is employed.

During 1908, 429,925 tons of copper ore mined in the district produced concentrates containing 14,776,363 pounds of copper, 4,559.44 ounces of gold, and 15,326 ounces of silver. The average recovery in concentrates per ton of ore for the district was, copper, 1.72 per cent; gold, 0.0106 ounce per ton; silver, 0.036 ounce per ton, a combined gold and silver value of about 24 cents per ton.

During the year the concentrating and smelting plant of the Cumberland-Ely and the Nevada Consolidated companies at McGill was completed. The first unit of the concentrator was completed in April and the remaining two later in the year. The plant at the close of the year consisted of 3 units, with a capacity of 1,300 tons of ore each. In 1909 another unit was completed and put in operation.

At the Steptoe Valley smelter operations were begun in July. At

[a] Bull. Dept. Geology Univ. California, No. 4, p. 287. A detailed investigation of this district by the Survey is now in progress.

the close of 1908 this plant consisted of McDougal roasters, blast furnace, 3 reverberatory furnaces, and 3 converter stands. An additional reverberatory and additional converters were added in 1909. The plant, at the close of 1908, had a smelting capacity of upward of 2,000 tons. All the raw materials for smelting operations except fuel are from the district. Siliceous ore for converter linings is obtained from the "dike" of siliceous copper ore in the Copper Flat pit, and limestone for fluxing is quarried near the smelter. The blister copper is shipped to Perth Amboy, N. J., for refining.

With the Steptoe plants working at full capacity, Ely will take its place among the important copper-producing camps in 1909.

Other districts.—At the Yerington district in Lyon County development was continued during the year, and considerable additions were made to the ore reserves. According to F. L. Ransome[a] there are three types of occurrences in the district: "(1) Irregular bodies formed by metasomatic replacement of limestone and genetically associated with metamorphism of a kind usually attributed to contact action of intrusive rocks; (2) metasomatic vein deposits in altered limestone; and (3) metasomatic vein deposits in granodiorite."

The most important developments are of ore bodies of the first type. The original sulphides of these are pyrite and chalcopyrite in various proportions, with a gangue of pyroxene, amphibole, epidote, garnet, and calcite. The ore is low grade, usually below 3 per cent. The Bluestone mine has the largest tonnage of ore developed. This was estimated in 1908 by C. A. Weck, superintendent of the mine, to be between 2,000,000 and 3,000,000 tons.

Ransome says of the district: "The total quantity of oxidized ore exposed in the district is small and there is no indication of any extensive sulphide enrichment. The quantity of gold and silver in the ores is practically negligible. The future of the district depends on the working of low-grade primary deposits. The conditions are in some respects favorable for cheap mining and concentrating; a railroad could be constructed from Wabuska along Walker River with very little difficulty; water is more plentiful than in most other parts of Nevada, and many agricultural products can be grown in Mason Valley."

Production was made from several other districts in the State, for the most part from lead-copper ores. Besides the ores treated within the State, Nevada ores producing copper were treated by smelters in California, Utah, and Colorado.

NEW MEXICO.

The production of blister copper in New Mexico in 1908 was 4,991,351 pounds, as compared with 10,140,140 pounds in 1907. This marked decrease is due to the fact that many of the small mines which were active in 1907 found it impossible to operate at a profit at the prices obtaining during 1908.

The Southwest Smelting and Refining Company operated for a part of the year, and the National Mining and Smelting Company produced some copper matte in its lead furnaces. The bulk of the ore was treated by the smelters of Texas and Arizona.

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[a] Yerington copper district, Nevada: Bull. U. S. Geol. Survey No. 380, 1909.

The following description of the mining districts is largely taken from the report of 1907:[a]

Santa Rita-Hanover district.—The deposits of the old Santa Rita district, east of Silver City, made an output of about 4,000,000 pounds in 1908, as compared with 5,000,000 pounds in 1907. The surface quartzite, which ranges up to 200 feet in thickness and is underlain by porphyry, carries cuprite and native copper in its countless fractures and joints. The known bodies of rich chalcocite ore in the porphyry have now been almost exhausted, and the bulk of the production in 1907 came from the quartzite ores. The deepest workings are slightly over 400 feet and are reached by shafts, and shallow pits with windlasses or whims serve the Mexicans in their leasing operations. The ore bodies in quartzite are commonly small and require little or no timbering. The native copper and cuprite are recovered mainly by cobbing and by the use of hand jigs, though a mill is operated part of the time. The rich concentrates are shipped to El Paso for smelting. The disseminated ore bodies of the Santa Rita Mining Company are being extensively prospected by means of churn drills.

In the Hanover section of the district, lying just east of Santa Rita, the ores occur chiefly as contact-metamorphic deposits in limestone. At the Hanover mine, another old working, the ores have been greatly oxidized and secondarily enriched. The Hermosa Copper Company produced heavy pyrite-chalcopyrite ores from limestone replacement bodies. The ores of this camp go to smelters in Arizona and at El Paso for treatment. Branch lines of the Santa Fe Railroad enter both this and the Santa Rita camp.

Burro Mountain district.—The Burro Mountain district, southwest of Silver City, showed a marked falling off in production from 1907. The principal producer was the Burro Mountain Copper Company, which operated a concentrating mill at its mine at Leopold for a part of the year. The deposits, which form irregular masses, contain chalcocite-coated pyrite in crushed and altered porphyry. The ore of workable grade has been produced by enrichment from above. The greater part of these ores are of concentrating grade. Some richer oxide ores carrying carbonates and chrysocolla occur in the district.

The mines are less than 400 feet deep and are not very wet. Square setting is employed in the stopes. Mexican labor is employed largely. The Comanche smelter at Silver City was not operated during 1908.

TENNESSEE.

In 1908 Tennessee produced 19,710,103 pounds of blister copper, as compared with 19,475,119 in 1907. The excess over mine production is due to the fact that some ore mined in 1907 did not reach the stage of blister copper till 1908. The entire product was from the Tennessee Copper Company and the Ducktown Sulphur, Copper, and Iron Company, operating in the Ducktown district.

Ducktown district.[b]—The Ducktown district, located in the extreme southeastern part of the State, in Polk County, was one of the earliest

[a] A report on the mining districts of New Mexico by the Geological Survey is now in preparation.

[b] The deposits have been described by Henrich, Carl, Am. Inst. Min. Eng., vol. 25, p. 173; Weed, W. H., Am. Inst. Min. Eng., vol. 30, p. 452; Kemp, J. F., Am. Inst. Min. Eng., vol. 31, p. 224; Higgins, E., Eng. and Min. Jour., vol. 86, 1908, pp. 1237–1241; Channing, J. P., Min. and Sci. Press, vol. 96, 1908, p. 97; Gottsberger, B. B., Mining World, vol. 29, 1908, pp. 911–914.

large producers in the country. Operations began in the district about 1850, and from that date till the close of the civil war there was a large production from the "black copper" ores. With the exhaustion of the rich secondary deposits attempts were made to work the lean original sulphides. These efforts met with only indifferent success, and in the late seventies the smelters shut down, thus ending the first period of activity in this district. The present period of activity began in 1890, when the Ducktown Sulphur, Copper, and Iron Company began operations. Since that time the district has been a steady producer from the primary sulphide ores.

The ores occur as steeply dipping lenses in a quartz-mica schist, the ore bodies in general conforming to the dip and strike of the schistosity of the inclosing rock. The principal sulphide is pyrrhotite, with subordinate pyrite and chalcopyrite. Extensive gossans cap the ore bodies, and it was the enriched zones underlying these that furnished the rich chalcocite ores that were extracted during the first period of activity.

In 1908 the ores of the district yielded a little over 31 pounds of blister copper per ton, or 1.55 per cent, with an average of 0.38 cent gold and silver per pound of copper that was electrolytically treated. A part of the copper is exported without electrolytic refining. The fact that the ores can be extracted without timbering, the cheap supply of coke and coal from Tennessee and West Virginia, and the comparatively low cost of labor make it possible to mine and treat these low-grade ores at a profit.

During 1908 the sulphuric acid plant of the Tennessee Copper Company, which was completed late in 1907, was in operation. Some changes were found necessary, especially in the furnace tops. At the close of the year the main difficulties had been overcome, and the plant was operating successfully.

The proximity of the phosphate rock supply makes it possible to market the large tonnage of acid produced by this plant at a profit for the manufacture of fertilizer. The company has thus apparently solved the "smelter smoke" question and probably added no small amount to the ultimate profits.

Pyrite smelting is successfully practiced by both companies. The low-grade matte produced by the first smelting is resmelted and brought to a proper grade for conversion.

White labor, largely American, is employed in the mines. The wages are low as compared with western districts.

The district is served by a branch line of the Louisville and Nashville Railroad, the mines and smelters of the companies being connected with this by private lines.

UTAH.

Utah produced 71,370,370 pounds of blister copper in 1908, as compared with 66,418,370 pounds in 1907. The production would doubtless have been considerably larger had it not been for the injunctions, early in the year, closing three smelters near Salt Lake—the Bingham Consolidated, the Utah Consolidated, and the United States smelters—on account of suits for damages by farmers of the district.

The marked difference between mine and smelter production is due to the fact that large stocks of concentrates had accumulated at the

Garfield smelter at the close of the year on account of difficulties experienced in smelting.

The production, as in 1908, was derived chiefly from 3 districts, the Bingham, Tintic, and Frisco.

Bingham district.—The Bingham or West Mountain district, Salt Lake County, made a blister output of about 56,000,000 pounds, as compared with 47,000,000 pounds for 1907. The mine output for the year was about 71,000,000 pounds, but much of this, for reasons already stated, had not reached the stage of blister copper at the close of the year. The increase in output was due to the production from the porphyry mines of the Utah Consolidated and the Boston Consolidated companies.

The ore deposits of the district[a] are closely associated with masses of monzonite intruded into a series of quartzites with intercalated beds of limestone and shale of Carboniferous age. The ores are of two types of occurrence—as irregular replacement of limestone near the monzonite contact, and disseminated through altered porphyry.

Previous to 1907, most of the copper from the district was derived from the contact deposits in limestone. These are massive bodies of pyrite carrying chalcopyrite in varying amounts. Secondary enrichment has not been of great importance in this type of deposit. The ores vary greatly in copper content, and consequently the average percentage derived for a given year depends largely on the grade that can be worked at a profit at the price of copper. In 1908 the ores yielded about 2.08 per cent copper, with $3.83 in gold and silver per ton of ore. About 503,000 tons of this type of ore was produced during the year, yielding nearly 21,000,000 pounds of copper.

The disseminated ores consist of grains of pyrite and chalcopyrite, scattered through altered monzonite. Many of the grains are partly or wholly replaced by secondary chalcocite, with some bornite. A large tonnage of these disseminated ores has been developed in the properties of the Utah Consolidated and the Boston Consolidated companies. In the deposits of the Ohio Copper Company the disseminated ores are more closely associated with fissures. This type of ore will undoubtedly be the most important source of copper in the district for some years to come.

During 1908 there were produced about 2,120,000 tons of monzonite ore, yielding 1.15 per cent copper, with 51 cents in gold and silver per ton. The average ratio of concentration was 21.4 into 1, yielding a concentrate carrying nearly 25 per cent copper.

The ore bodies in the limestone are worked for the most part by the square-set system. The porphyry bodies are worked by steam shovels and the caving system. The comparatively thin overburden makes the working of the porphyry deposits by steam shovels unusually cheap.

Previous to 1908 most of the ores were treated by the smelters operated by the several companies in the neighborhood of the mines. With the closing of the three plants mentioned above, the Garfield smelter of the American Smelting and Refining Company and the Yampa smelter were the only works treating copper ores. The International Smelting Company is constructing a 2,000-ton smelter

[a] For detailed information, see Boutwell, J. M., Prof. Paper U. S. Geol. Survey No. 38, 1905

in Pine Canyon, Tooele County, for the treatment of the output of the Utah Consoldiated Company's mines and custom ores. The development of the disseminated deposits has resulted in the construction of 3 concentrating plants during the last two years. These, together with 1 of earlier construction, give the district a concentrating capacity of over 12,000 tons daily. The plant of the Utah Copper Company at Garfield, of 6,000 tons capacity, was completed during the year, a part of the plant having been put in operation in 1907. This, with the 800-ton Copperton plant in Bingham Canyon, gives this company a concentrating capacity of nearly 7,000 tons. Through the year the sections of the Boston Consolidated plant at Garfield were placed in commission as completed. The 2,250-ton plant of the Ohio Copper Company, located about three-fourths of a mile east of the portal of the Mascotte tunnel, was not completed in 1908, but is expected to be placed in commission during 1909.

Most of the heavy pyritic ores of the district are smelted after roasting. The concentrates treated at the Garfield plant are roasted and smelted in reverberatories for the most part, though a part are sintered and treated in the blast furnace.

The Independent Smelting Company, successors to the Utah Smelting Company, operated the plant near Ogden for a part of the year, but closed down in December.

A 100-ton experimental furnace of the Fink type was constructed at Garfield during the year. This furnace, a combined roasting and smelting plant, is designed to utilize the fuel value of the sulphur and iron in smelting the ores, and it is claimed that very high-grade matte and even blister copper can be produced at one operation. An experimental run was made early in 1909 in which high-grade matte was produced. It has not yet been demonstrated that this process will be of commercial importance.

Tintic district.—The Tintic district, in Juab County, made a copper production of about 5,700,000 pounds in 1908, as compared with 7,800,000 pounds in 1907.

The sedimentary series,[a] consisting of limestone and quartzite of Carboniferous age, has been intruded by an extensive mass of monzonite.

The ores occur as contact deposits at the contact of limestone and monzonite, filling fissures in the igneous rocks, and as replacement of limestone and filling of fissures in the sedimentary series. The most valuable deposits developed are of the last-named type. The fissures are usually nearly vertical, and the replacement bodies are extremely irregular in form and various in size. The original minerals were pyrite, galena, sphalerite, and enargite, with rich silver and gold minerals in a gangue of quartz and barite.

There has been little development below the water level, which is usually below 1,600 feet in the deposits in limestone, and oxidation to this point has been very complete. Recent developments below the water level in the Gemini mine have been encouraging, revealing sulphide ores of high grade. More development will be necessary, however, to determine whether the primary ores of the district will prove

[a] For detailed report, see Tower and Smith, Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1899, pp. 601-767.

of great commercial importance. The district is primarily a precious metal camp, lead and copper being of secondary importance.

The smelting plant of the Tintic Smelting Company treated only lead ores during 1908, but a copper furnace was placed in operation early in 1909.

Frisco district.—The Frisco district of Beaver County produced about 5,500,000 pounds of copper in 1908, as compared with about 4,900,000 pounds in 1907. The production was principally from the Cactus mine of the Newhouse Mines and Smelting Company.

The ores,[a] which consist of pyrite and chalcopyrite, occur disseminated in a highly altered and brecciated area of monzonite. Most of the ore is low grade, and requires concentration before shipping.

The mine has been opened to the 900-foot level, and a large tonnage of ore has been developed. The upper part of the deposit was mined by steam shovel. The square set and filling system was employed previous to 1908, when the mine was put in shape for the use of the caving system. The company's 1,000-ton mill was reconstructed during 1908, and the capacity considerably increased. Several deposits in this district that were worked in 1907 made no production in 1908.

Other districts.—Other districts that contributed to the output of the State were the Little Cottonwood, in Salt Lake County; the Ophir district, in Tooele County; the Tutsagubet district, in Washington County; the Copper Mountain, in Boxelder County; and the Park City mines.

OTHER STATES.

Alabama.—Alabama made a small blister production in 1908. As in 1907, the copper was derived from the treatment of pyrite cinders produced in the manufacture of acid.

Maryland.—Only a few hundred pounds were reported from Maryland in 1908.

Missouri.—As in 1907, the North American Lead Company, at Fredericktown, Madison County, was the only producer of copper in the State. The ore consists of chalcopyrite, galena, and a nickel-cobalt mineral. This is concentrated with separation of the lead, and the copper-nickel-cobalt concentrates are treated by a process not made public.

New Hampshire.—Coos County made a production of about 128,000 pounds in 1908 from the mines of the Milan Mining and Milling Company.

North Carolina.—The production of blister from North Carolina showed a marked decrease in 1908, 14,342 pounds being reported, as compared with 544,040 pounds for 1907. The two principal districts of the State are the Gold Hill, Rowan County, and the Virgilina district, in Person and Granville counties. The latter district showed little activity in 1908.

Oregon.—The blister production in Oregon in 1908 was 271,191 pounds, as compared with 518,694 pounds in 1907. The Takilma smelter in Josephine County was the only plant in operation during the year and this, as in previous years, was able to operate but a few months on account of the bad condition of the roads, which made the

[a] Emmons, F. S., Bull. U. S. Geol. Survey No. 26, 1905, pp. 242–248. A report on the district is in preparation by the Survey.

42-mile haul to Grants Pass impracticable. The matte produced by this plant is shipped to Tacoma for conversion; the Tacoma plant also treats ore from Oregon.

Texas.—Texas made a small production of copper in 1908, from prospects in El Paso County. These ores were treated at the El Paso plant of the American Smelting and Refining Company.

Virginia.—Virginia made a production of 25,087 pounds in 1908, as compared with 57,008 pounds in 1907. The principal producer in 1908 was the Seaboard Copper Company in the Virgilina district. A small quantity was derived from ores mined for sulphur. At Dumfries, in Prince William County, some matte was produced from chalcopyrite ore sorted from the pyritic material.

Washington.—The blister production from Washington for 1908 was 162,201 pounds, as compared with 122,263 pounds for 1907. The principal production was by the Northport Smelting and Refining Company, and custom ore was treated by the Tacoma smelter. The numerous small plants that have recently been installed in the State were not operated during 1908.

Wyoming.—The production of blister copper reported from Wyoming was 2,416,197 pounds, as compared with 3,026,004 pounds in 1907. As in 1907, the main producer was the Penn-Wyoming Copper Company operating in the Encampment district, Carbon County. This company's smelter was in operation 119 days during the year.

The most important deposits of the Encampment district[a] occur in a zone of brecciated quartzite underlying schist. The original ore was chalcopyrite with possibly some pyrite. Secondary enrichment has produced important bodies of chalcocite in the upper workings, but these give place to chalcopyrite at depth.

REFINERY PRODUCTION.

The refinery output of the United States was made by 14 plants, 9 of which employ the electrolytic method, and 5 employ the furnace process on Lake Superior copper. Six of the large electrolytic refineries are located on the Atlantic tide water, and the 5 lake refineries are all located on the Great Lakes, 4 in Michigan and 1 in New York. The remaining refining companies are located at Great Falls, Mont.; Fredericktown, Mo.; and Blue Island, Ill. The Buffalo plant employs both the electrolytic and the furnace refining method; the Blue Island plant turns out only casting copper. In contrast to the smelting industry, which shows a marked tendency to move to the mining centers, the refining industry shows a tendency to concentrate on the Atlantic seaboard. Two electrolytic refineries that were operated previous to 1907 on the Pacific coast were closed during that year, and the output of the smelters has since been shipped east for refining. At present the Great Falls plant is the only large refinery west of the Great Lakes. The Atlantic refineries, besides turning out a very large percentage of the 656,179,349 pounds of domestic electrolytic, also produced 218,716,268 pounds of electrolytic copper of foreign origin.

The refined output is in the form of casting, Lake, and electrolytic copper.

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[a] Spencer, A. C., Prof. Paper U. S. Geol. Survey No. 25, 1904.

CASTING COPPER.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and cast into ingots. This copper is usually unfit for the uses requiring a high-grade copper, such as electrolytic purposes, brass manufacture and rolling, but is suitable for copper castings, and a large part of it is put to this use. A comparatively small percentage of the copper output, except that from the Lake district, carries such low values in precious metals that, together with the increased value of the electrolytic product, they will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is comparatively small. During 1908 the production of new casting copper amounted to 24,301,407 pounds, 24,166,681 pounds being of domestic origin and 134,726 pounds of foreign origin. As in previous years a large percentage of this came from the Morenci-Metcalf district, Arizona, with a small quantity from Wyoming and other States. During 1908 there were 43,262,285 pounds of blister exported without refining. This export was principally from the Morenci-Metcalf district, Arizona, and Ducktown, Tenn., and as it was very low in precious metals it was probably used for casting purposes without refining. During 1908 the regular copper-refining companies of the country recovered 9,705,103 pounds (of which 2,551,077 pounds were electrolytically refined and 7,154,026 pounds were casting) from domestic scrap, drosses, etc., and returns from most of the known refiners of secondary material show that 13,508,574 pounds were turned out by them as casting copper or in alloys. At least 23,213,677 pounds of copper were derived from secondary sources during the year, and undoubtedly this quantity would be somewhat increased if all the secondary producers reported.

LAKE COPPER.

By Lake copper as used in this report is meant the output of the Lake Superior district that is refined by the furnace method. The copper from the district that is electrolytically refined is considered as electrolytic copper. This does not agree exactly with the term Lake copper as used in the trade, Lake copper being not only the furnace refined product from the Lake district, but also mixtures of furnace refined and electrolytically refined copper from the Lake district, and furnace refined copper from the Lake district with electrolytic copper from other districts. The mixing is resorted to in order to dilute the arsenic in certain grades of the furnace-refined copper. This subject has been fully treated in the preceding report [a] and need not be repeated in detail.

There were 195,503,099 pounds of furnace-refined Lake copper produced in 1908, and 26,786,485 pounds were electrolytically refined either to free the copper from impurities or to recover the silver content.

ELECTROLYTIC COPPER.

By electrolytic copper is meant copper that has been electrolytically refined regardless of its origin. In 1908 the production of electrolytic copper from primary materials of domestic origin amounted

[a] Mineral Resources U. S. for 1907, pt. 1, U. S. Geol Survey, 1908, p. 623.

to 656,179,349 pounds, as compared with 592,326,608 pounds in 1907, and there were 218,716,268 pounds of foreign origin, as compared with 245,062,814 pounds in 1907. Electrolytic copper from secondary sources to the amount of 2,551,077 pounds was produced, making a total electrolytic production for the year of 877,446,694 pounds, as compared with 845,706,283 pounds in 1907.

The copper content of the bluestone turned out by the refineries during 1908 was approximately 9,674,773 pounds, or about 1.10 per cent of the copper subjected to electrolytic treatment.

TOTAL REFINED COPPER.

The total production of refined new copper for 1908 was 1,094,700,123 pounds, the largest output in the history of the industry, exceeding the 1906 production of 1,079,052,409 pounds by 15,647,714 pounds, and the 1907 output of 1,032,516,247 pounds by 62,183,876 pounds.

The production of electrolytic, Lake, and casting copper for 1907 and 1908 is shown in the following table:

Production of refined copper in 1907 and 1908, in pounds.

	1907.		1908.	
	Domestic origin.	Foreign origin.	Domestic origin.	Foreign origin.
Electrolytic	592,326,608	245,062,814	656,179,349	218,716,268
Lake	178,534,141	.....	195,503,099	.....
Casting	13,410,678	3,182,006	24,166,681	134,726
Total	734,271,427	248,244,820	875,849,129	218,850,994
Total output, domestic refineries	1,032,516,247		1,094,700,123	

The 1908 figures for domestic electrolytic include 26,786,485 pounds of Lake copper which were refined electrolytically; those for 1907 contain 34,917,988 pounds of Lake copper.

If to the 875,849,129 pounds of refined output from primary sources of domestic origin is added the 43,262,285 pounds of blister copper exported, and so far as known consumed without refining, the total output of marketable copper from primary sources in the United States was 919,111,414 pounds. Add to this the 218,850,994 pounds derived from foreign sources and the 23,213,677 pounds from secondary sources, and the contribution of the United States plants to the world's supply of marketable copper is found to be 1,161,176,085 pounds, or 69 per cent of the world's output for 1908.

COPPER SULPHATE.

The production of copper sulphate or bluestone by the refineries of the United States, in 1908, was 38,240,211 pounds, having a copper content of 25.3 per cent, or 9,674,733 pounds, as compared with about 33,464,950 pounds, with a copper content of about 8,466,632 pounds, in 1907.

STOCKS.

Returns from all smelting and refining companies show that the following stocks of electrolytic, Lake, and casting copper were on hand at the beginning and end of the year 1908:

Stock of refined copper, in pounds.

January 1, 1908	125,745,796
January 1, 1909	121,876,759
Stocks decreased during 1908	3,869,037

Undelivered sales are excluded from these figures. Stocks carried by consumers and brokers have not been ascertained. In addition to the stocks of refined copper there were at smelters, in transit to the refineries, and at the refineries, blister copper and material in process of refining to the amount of 175,254,659 pounds, January 1, 1908, and of 234,013,843 pounds, January 1, 1909.

Stocks were accumulating during the last months of the year and continued to do so during the early part of 1909. By the middle of the year, however, production and consumption were about equal.

IMPORTS AND EXPORTS.

IMPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1908 was 218,705,487 pounds, according to the records of the Bureau of Statistics of the Department of Commerce and Labor. The imports in 1907 were 252,620,054 [a] pounds. The following table shows the character and source of copper-bearing materials inported during 1907 and 1908: [b]

Imports of copper into the United States in 1907 and 1908, by countries, in pounds.

Country.	Ore, matte, and regulus (copper content).	Ore.	Matte and regulus.	Pigs, bars, ingots, plates, old, etc.	
	1907.	1908.	1908.	1907.	1908.
United Kingdom				25,706,852	5,434,435
France				606,662	168,506
Germany				6,814,338	1,451,370
Other Europe				5,616,261	13,359,117
British North America	12,803,069	8,326,728	2,859,969	30,902,596	30,895,737
Mexico	32,467,418	15,775,626	128,066	76,741,532	43,742,993
Cuba				767,184	349,560
Other West Indies and Bermuda				401,585	184,490
Peru	8,790,621	9,054,852		14,945,697	23,646,921
Other South America				8,349,374	2,418,672
Japan				9,809,569	8,329,896
Other countries	5,657,679	15,652,830	4,683,272	12,239,617	32,242,447
Total	59,718,787	48,810,036	7,671,307	192,901,267	162,224,144
Grand total				252,620,054	218,705,487

[a] The change in this figure from that published in the 1907 report is due to corrections made in the records of the Bureau of Statistics.

[b] Owing to the fact that unmanufactured copper is not dutiable a less accurate account of copper imports is kept than of dutiable articles. The separation of ore and matte is evidently not accurate, though combined ore and matte are more nearly correct.

The total imports of 218,705,487 pounds include 7,067,092 pounds of copper in matte and blister derived from ores from the United States, leaving 211,638,395 pounds of foreign origin.

According to reports from smelters and refineries, 218,850,994 pounds were derived from foreign sources, making a discrepancy of 7,212,599 pounds between the figures reported by smelting and refining companies and those of the Bureau of Statistics. If losses in smelting and refining of the imported materials were taken into consideration, the discrepancy would be considerably greater.

The following table shows imports for consumption:

Imports for consumption, 1908, in pounds.

Ore, copper content	40,477,621
Matte, copper content	13,551,189
Copper, unmanufactured regulus, etc	358,990
Copper, old, fit for remanufacture	2,182,839
Copper, plates, bars, etc	158,041,552
	214,612,191

It will be noted that the total of "Imports for consumption" are less than "Imports by countries," and the discrepancy between the figures of imports for consumption and those of the smelters and refineries are correspondingly greater.

EXPORTS.

The exports of metallic copper from the United States in 1908 amounted to 661,876,127 pounds, according to the Bureau of Statistics. This is the largest export made in any year, exceeding that of 1904 by 107,326,097 pounds, and that of 1907 by 152,946,726 pounds. In addition to the exports of metallic copper, the copper contents of 63,149 long tons of ore, matte, and regulus were exported in 1908, as compared with 99,144 long tons in 1907.

Exports of domestic copper from the United States in 1907 and 1908, by countries.

Country.	Ore, matte, and regulus. (Gross weight in long tons.)		Ingots, bars, plates, and old. (Pounds.)	
	1907.	1908.	1907.	1908.
United Kingdom	200	168	81,409,441	117,810,314
Belgium			3,822,551	5,560,366
France			93,075,145	115,690,381
Germany	188	2	107,607,390	137,453,392
Italy			21,192,908	25,512,267
Netherlands			156,562,270	195,562,619
Russia			4,341,386	4,657,077
Other Europe			26,221,024	39,433,674
British North America	82,016	55,367	3,747,410	3,977,142
Mexico	16,737	7,060	362,411	35,895
Chinese Empire			10,003,592	13,735,899
Other countries		552	493,873	2,447,101
	99,141	63,149	508,929,401	661,876,127

The exports to the different countries show a rather uniform increase, the large exportations being due to the low price of copper during the year, which stimulated the purchase of copper by foreign countries.

The exports of pigs, bars, plates, and old, in 1908 included43,262,285 pounds of blister; in 1907 it included 42,350,463 pounds. The deduction of this quantity from the total gives 618,613,842 pounds of refined copper exported in 1908 as compared with 465,496,007 in 1907.

CONSUMPTION.

The apparent consumption of refined new copper in the United States in 1908 was about 480,000,000 pounds, as compared with about 488,000,000 pounds in 1907. As it is practically impossible to ascertain the consumption by a direct method, the most feasible method appears to be to deduct the total copper withdrawn from supply during the year from the total supply. If these data are correct, the apparent consumption will probably be very close to the actual consumption. Since all refining companies have furnished figures showing stocks on hand, the data are complete and believed to be accurate for ascertaining the consumption by this method.

The following table shows the apparent consumption of refined new copper in the United States in 1907 and 1908:

Domestic consumption of refined copper in 1907 and 1908, in pounds.

	1907.	1908.
Total refinery output	1,032,516,247	1,094,700,123
Stock at beginning of year	46,497,181	125,745,796
Total available supply	1,079,013,428	1,220,445,919
Refined copper exported	465,496,007	[a] 618,613,842
Stock at end of year	125,745,796	121,876,759
Total withdrawn from supply	591,241,803	740,490,601
Apparent consumption	487,771,625	479,955,318

[a] Exports of pigs, bars, ingots, plates, etc., reported by the Bureau of Statistics, less 43,262,285 pounds of blister exported without refining.

About 55 per cent of the domestic product of refined copper was consumed in the United States. If to the refined product are added the 43,262,285 pounds exported without refining, it is found that in 1908 about 48 per cent of the copper derived from ores mined in the United States was exported. This compares with 41 per cent in 1907 and 24 per cent in 1906.

To the apparent consumption of new copper should be added that produced from secondary sources, a large part of which entered into the year's consumption. This amounted to about 23,000,000 pounds in 1908, and about 60,000,000 pounds in 1907, making a total consumption of about 503,000,000 pounds in 1908, as compared with about 547,000,000 pounds in 1907.

USES.

No systematic attempt has been made to ascertain the proportion of the copper output of 1908 used in different industries for electrolytic purposes, brass manufacture, casting, etc. Some idea, however, of the quantities entering the different industries can be gained

from the forms in which the output of the refineries was cast. The following table shows the approximate quantity of copper cast in the different forms during 1908. In a few instances these are estimates made by the refining company, an accurate account of the form in which the output was cast not being available. They are believed, however, to correspond very closely to the actual forms in which the copper was put on the market.

Forms in which the refinery output was cast in 1908, in pounds.

Form.	Electrolytic.	Lake.	Casting.	Total.	Percentage.
Wire bars	506,075,345	16,472,540		522,547,885	47
Ingots	118,734,392	139,394,946	29,629,433	287,758,771	26
Cakes	76,831,965	53,936,578		130,768,543	12
Cathodes	126,794,321			126,794,321	12
Other forms	21,061,000	[a] 12,485,580		33,546,580	3
Total	849,497,023	222,289,644	29,629,433	[b] 1,101,416,100	100

[a] Includes some copper "in process."
[b] It will be noted that this total is somewhat smaller than the total of refinery output of new and old copper in 1908.

It may be assumed that a large portion of the 47 per cent of the copper output cast as wire bars was used for electrical purposes, and that the 12 per cent cast as cakes was used largely for rolling. The other forms are less easily classified. The 12 per cent cast as cathodes, together with a portion of the ingots, entered the brass industry, and a large amount of copper ingots were used in casting. It was estimated, on more complete data, that the consumption in 1907 was in the following proportions: Electrical purposes, 45.3 per cent; brass manufacture, 30.9 per cent; rolling mills, sheet copper, 6.2 per cent; miscellaneous uses, principally casting, 17.6 per cent.

PRICES.

The average quoted price of electrolytic copper at New York, in 1908 was 13.2 cents per pound. In 1907 the price was 20 cents per pound. The average monthly prices for electrolytic copper in 1907 and 1908 are given in the following table:

Monthly prices per pound of copper in 1907 and 1908.

Month.	Prices of electrolytic copper, in cents.		Month.	Prices of electrolytic copper, in cents.	
	1907.	1908.		1907.	1908.
January	24.40	13.72	August	18.35	13.46
February	24.86	12.90	September	15.56	13.38
March	25.06	12.70	October	13.16	13.35
April	24.22	12.74	November	13.39	14.13
May	24.04	12.59	December	13.16	14.11
June	21.66	12.67			
July	22.13	12.70	Average	20.00	13.20

The average yearly price of Lake copper was 13.4 cents. These quoted prices are the basis on which much of the copper is sold by the mines and are used by the Geological Survey in calculating the value

of mine production. It is well known, however, that it only roughly represents actual average price received for copper sold during the year. The actual average price is, however, probably much nearer to the quoted average in a year like 1908, when the market fluctuations were relatively small, than in a year like 1907, when differences in prices were very large and the variations in sales in different months were great.

WORLD'S PRODUCTION.

The smelter production of copper in the world was 1,667,098,000 pounds in 1908, as compared with 1,589,809,300 pounds in 1907. In 1908 the smelter output of the United States was 56.54 per cent of the world's production, as compared with 54.66 in 1907.

The following table shows the world's production, by countries. The figures are those compiled by Messrs. Henry R. Merton & Co. (Limited), of London, reduced to pounds, except that the official figures of the United States production are inserted.

World's production (smelter output) of copper in 1907 and 1908, in pounds.

Country.	1907.	1908.	Country.	1907.	1908.
Algeria	156,800		Mexico	126,705,600	84,156,800
Argentina	492,800	504,000	Namaqualand	5,600,000	
Australasia	92,400,000	88,480,000	Newfoundland	3,875,200	3,203,200
Austria	2,060,800	3,528,000	Norway	16,702,400	20,585,600
Bolivia	5,600,000	5,600,000	Peru	23,688,000	33,600,000
Canada	57,377,600	63,996,800	Russia	33,600,000	44,990,400
Cape Colony	9,475,200	15,411,200	Spain	111,272,000	117,790,400
Chile	59,774,400	85,825,600	Portugal		
England	1,568,000	1,568,000	Sweden	4,480,000	4,480,000
Germany	45,897,600	45,248,000	Turkey	2,800,000	2,352,000
Hungary	280,000	224,000	United States	868,996,500	942,570,000
Italy	7,392,000	6,664,000			
Japan	109,614,400	96,320,000	Total	1,589,809,300	1,667,098,000

LEAD.

By C. E. Siebenthal.

INTRODUCTION.

An estimate of the production of refined lead in 1908 was given out in the form of a press bulletin on January 1, 1909. This was based on reports from every smelter giving the actual production for the first ten or eleven months, with estimates for the remainder of the year. The total thus obtained varied 1.4 per cent from the final figures of production. The complete figures of production and consumption of primary[a] refined lead, of imports and exports of lead in ore and bullion, and of the recovery of secondary lead were given in the advance statement of lead production, which was published May 24, 1909. The present report contains, in addition, tables showing the production, consumption, imports and exports for a period of years, a comparison of the mine and the smelter production of lead by States, and a summary of metallurgical advance and of trade conditions for the year.

The statistics of production in this country are based upon confidential returns to the Survey by each lead-smelting company in operation during the year. The statistics of domestic consumption are taken in part from these smelter returns and in part from the records of the Bureau of Statistics of the Department of Commerce and Labor, and the tables for foreign production and consumption are compiled from the sources indicated.

The collection of the figures of mine production in the Central States in 1907 and 1908 allows a comparison of smelter and mine state totals for all lead-producing States for two years in succession, thus to a certain extent eliminating the lag in smelting and affording a truer comparison.

STATE OF LEAD INDUSTRY IN 1908.

The lead industry had an earlier recovery from the depressed conditions prevailing at the close of 1907 than did the spelter industry. After maintaining a stationary condition for several months, lead prices rose rapidly until late summer and then fell gradually until the close of the year.

With the recovery of prices, lead mining was stimulated, but a considerable portion of the increased output of ore was marketed too late in the year to enter into the production of pig lead. Of the principal lead-producing States, Missouri alone showed an increase in

[a] By primary lead is meant lead which has been produced directly from ore. This term is used for purposes of distinction from secondary lead, which is obtained by refining skimmings, drosses, old metals, etc., figures for the production of which are given on a later page. Wherever in this report the word "lead" is used without qualification primary lead is to be understood.

the quantity of lead mined, thus retaining the first rank in lead production. Idaho and Utah both showed a decreased production, but Colorado had the greatest decrease, amounting to over 40 per cent. There was an increase of 75 per cent in the quantity of Mexican base bullion refined in bond in this country over the quantity refined in 1907, so that the total lead refined in this country makes a somewhat better showing than the domestic production.

PRODUCTION.

The production of lead in the United States since 1825 from domestic ores and from foreign ores and base bullion is shown in the table following. For the early years, in the absence of official records, the figures have been compiled from the best available sources. The figures for the period from 1825 to 1853 are those published by Whitney; those for the later years were collected by E. A. Caswell. Totals for 1882 were compiled from statistics gathered by the Census Bureau. Since 1882 the figures have been annually collected by the United States Geological Survey.

According to Hahn,[a] argentiferous lead ore was smelted in Montana and Nevada as early as 1866–67, but for the silver only, as the value of the lead would not pay transportation charges to market. With the completion of the Union Pacific Railroad in 1869 and the development of the mines at Eureka, Nev., the production of lead bullion began. The first figures of this production which are available are for 1873. It is evident from the totals for 1871 and 1872 that not much bullion was produced before 1873. Estimates have been made for these years, as well as for 1874, in order to arrive at totals for the different classes of lead. Foreign bullion, principally from Mexico, began in 1891 to be imported into this country for refining, but before 1906 the annual quantities so imported were not distinguished from the lead imported in ore. Since the soft lead is all domestic, the desilverized lead of domestic origin can be readily found by subtracting the total lead of foreign origin from the total desilverized lead production of that year, or by subtracting the soft lead from the total domestic lead of that year. Previous to 1906 the total production of antimonial lead is included in the production of refined, desilverized lead, but since that date it has been excluded.

Production of refined lead in the United States, 1825–1908, in short tons.

Year.	Antimonial lead.[b]	Desilverized lead.[c]	Soft lead.	Total production.[c]	From domestic ores and base bullion.	From foreign ores.[d]	From foreign (Mexican) base bullion.[e]
1825–1868			676,200	676,200	676,200		
1869			17,500	17,500	17,500		
1870			17,830	17,830	17,830		
1871		*f* 1,000	*f* 19,000	20,000	20,000		
1872		*f* 5,330	*f* 20,500	25,880	25,880		
1873		20,159	22,381	42,540	42,540		
1874		*f* 28,524	*f* 23,556	52,080	52,080		
1875		34,909	24,731	59,640	59,640		
1876		37,649	26,421	64,070	64,070		
1877		50,748	31,152	81,900	81,900		
1878		64,290	26,770	91,060	91,060		

[a] Mineral Resources U. S. for 1882, 1883, p. 324.
[b] Included also under desilverized lead and total production prior to 1906.
[c] Including also antimonial lead, except for 1906–1908, inclusive.
[d] Including also lead from foreign base bullion for 1891–1905, inclusive.
[e] Included in lead from foreign ore previous to 1906.
f Estimated.

Production of refined lead in the United States, 1825–1908, in short tons—Continued.

Year.	Antimonial lead.	Desilverized lead.	Soft lead.	Total production.	From domestic ores and base bullion.	From foreign ores.	From foreign (Mexican) base bullion.
1879		64,650	28,130	92,780	92,780		
1880		70,135	27,690	97,825	97,825		
1881		86,315	30,770	117,085	117,085		
1882		103,875	29,015	132,890	132,890		
1883		122,157	21,800	143,957	143,957		
1884		119,965	19,932	139,897	139,897		
1885		107,437	21,975	129,412	129,412		
1886		114,829	20,800	135,629	130,629	[a] 5,000	
1887		135,552	25,148	160,700	145,700	[a] 15,000	
1888		151,465	29,090	180,555	151,919	28,636	
1889		153,709	29,258	182,967	156,397	26,570	
1890		130,403	31,351	161,754	143,630	18,124	
1891	[b] 4,043	171,009	31,397	202,406	178,554	23,852	
1892	[b] 5,039	181,584	31,678	213,262	173,305	39,957	
1893	[b] 5,013	196,820	32,513	229,333	163,982	65,351	
1894		181,404	37,686	219,090	159,351	59,739	
1895		201,992	39,890	241,882	165,709	76,173	
1896	[b] 7,507	221,457	43,537	264,994	187,256	77,738	
1897	[b] 8,867	247,483	43,553	291,036	207,365	83,671	
1898	[b] 8,473	267,842	42,779	310,621	210,676	99,945	
1899	[b] 6,345	263,826	40,566	304,392	208,466	95,926	
1900	[b] 9,906	329,658	48,021	377,679	270,824	106,855	
1901	[b] 10,656	323,790	57,898	381,688	269,266	112,422	
1902	[b] 9,169	303,011	74,050	377,061	276,455	100,606	
1903	[b] 9,579	295,074	83,444	378,518	290,194	88,324	
1904	[b] 11,001	315,284	89,169	404,453	308,603	95,850	
1905	[b] 10,995	296,186	103,116	399,302	318,509	80,793	
1906	10,546	313,886	90,860	404,746	336,200	28,803	39,743
1907	9,910	314,241	99,948	414,189	337,340	43,925	32,924
1908	13,629	295,420	101,013	396,433	298,672	40,272	57,489
		6,323,068	1,635,918	8,635,236	7,091,548	1,543,688	

[a] Estimated.
[b] Included also under desilverized lead and total production prior to 1906.

PRODUCTION BY STATES.

The lead content of ores mined and smelted in this country from 1901 to 1905, inclusive, is given below by States from which the ores were derived. The figures were compiled from smelter reports and it should be noted that they represent the content of the ores and not the actual recovery, which is the quantity available for consumption. The latter quantity, termed merchant lead, has regularly been derived from the figures for lead content by allowing 5 per cent loss therefrom for smelting, desilverizing, and refining.

Lead content of ores smelted by the works in the United States, 1901–1905, by States, in short tons.

State or Territory.	1901.	1902.	1903.	1904.	1905.
Colorado	73,265	51,833	45,554	51,884	56,638
Idaho	79,654	84,742	99,590	108,854	99,027
Utah	49,870	53,914	51,129	56,470	44,996
Montana	5,791	4,438	3,303	3,635	2,207
New Mexico	1,124	741	613	1,363	1,232
Nevada	1,873	1,269	2,237	1,873	2,206
Arizona	4,045	599	1,493	1,499	2,091
California	381	175	55	163	116
Washington	1,029	1,457	538	622	56
Oregon, Alaska, South Dakota, Texas		2,184	1,765	41	101
Missouri, Kansas, Wisconsin, Illinois, Iowa, Virginia, and Kentucky	67,172	79,445	86,597	92,275	104,058
Total lead content American ores smelted	284,204	280,797	292,874	318,679	312,728
Content Mexican ores	11,841	8,755	56,890	24,952	
Content Canadian ores	9,615	2,164	253	11	
Content miscellaneous or unknown	804	3,975	2,831	1,113	

The closer distribution of the lead production among the States from which the ore was derived has necessitated the separate table which follows. The product of refined lead can with difficulty be apportioned according to sources of ore, owing to the fact that lead refiners treat smelted products whose origin may, as in custom refining, be unknown to them, the identity of the ore and thus its original source being preserved only as far as the smelter. Accordingly, this table, showing sources of lead smelted or refined in the United States, is based as far as possible on smelter figures. It includes "pig lead" reported by all known smelters running on Mississippi Valley or southern lead ores, and "lead" produced at all other lead smelters in this country. The greater part of the product reported by smelters operated in conjunction with refineries is in terms of refined lead. A like part of the antimonial lead product is thus eliminated from the "lead" produced and appears only in the figures of production of antimonial lead. No lead ore from the United States was treated elsewhere during the period covered by the table.

Sources of primary lead smelted or refined in the United States, 1906–1908, in short tons.

Source of ore.	1906.		1907.		1908.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Domestic ore:						
Alaska	8	0.002			3	0.001
Arizona	2,884	.83	2,340	0.64	1,464	.47
Arkansas			15	.004		
California	432	.12	854	.23	515	.17
Colorado	50,497	14.51	48,876	13.43	28,728	9.28
Georgia			2	.0005		
Idaho	117,117	33.65	112,569	30.94	98,464	31.82
Illinois	572	.16	498	.14	363	.12
Iowa	270	.08	225	.06	110	.03
Kansas	1,932	.56	1,798	.49	2,293	.74
Kentucky	44	.01	75	.02		
Missouri	111,075	31.91	122,856	33.77	122,451	39.57
Montana	2,485	.71	2,035	.56	2,320	.75
Nevada	1,669	.48	3,380	.93	3,796	1.23
New Mexico	640	.18	1,927	.53	586	.19
Oklahoma			404	.11	1,409	.45
Oregon					7	.002
South Dakota					13	.003
Tennessee	11	.003	16	.004		
Texas	25	.011	10	.002	42	.01
Utah	56,260	16.16	61,699	16.96	42,455	13.72
Virginia			82	.02	13	.004
Washington	46	.015	281	.08	391	.13
Wisconsin	1,753	.50	3,551	.98	4,013	1.30
Undistributed	380	.109	355	.10	36	.01
Zinc residues	2,053		1,318		1,290	
Total from domestic ore	350,153	100	365,166	100	310,762	100
Foreign ore:						
Africa			323			
British Columbia	7,238		5,793		341	
Central America	112				12	
China	18				4	
Mexico	21,435		36,749		38,729	
South America			911		1,186	
Other foreign			149			
Foreign base bullion:						
Mexico	39,743		32,924		57,489	
Total from foreign ore and base bullion	68,546		76,849		97,761	
Grand total, derived from all sources	418,699		442,015		408,523	

SOFT LEAD.

The quantity of soft lead recovered in 1907–8, apportioned according to the source of the ore, as compiled from direct returns by smelters to the Survey, is shown in the following table. In these totals the soft lead which was desilverized is included.

Production of soft lead in the United States in 1907–8, by States, in short tons.

Source of ore.	1907.		1908.	
	Quantity.	Percentage of total soft lead.	Quantity.	Percentage of total soft lead.
Arkansas	15	0.01	.....	.....
Illinois	498	.39	363	0.28
Iowa	225	.17	110	.08
Kansas	1,798	1.39	2,293	1.75
Kentucky	75	.06	.....	.....
Missouri	122,856	94.79	122,451	93.56
Oklahoma	404	.31	1,409	1.08
Tennessee	16	.01	.....	.....
Virginia	82	.06	13	.01
Washington	87	.07	230	.18
Wisconsin	3,551	2.74	4,013	3.06
	129,607	100	130,882	100

ANTIMONIAL LEAD.

The production of antimonial lead from ores derived from all sources, as reported direct to this office by all desilverizers operating in this country, is shown in the following table:

Production of antimonial lead in the United States from 1891 to 1908, in short tons.

1891	4,043	1900	9,906
1892	5,039	1901	10,656
1893	5,013	1902	9,169
1894	.....	1903	9,579
1895	.....	1904	11,001
1896	7,507	1905	10,995
1897	8,867	1906	10,546
1898	8,473	1907	9,910
1899	6,345	1908	13,629

The antimony contents of the production of antimonial lead for 1907 is estimated at 1,561 tons; that for 1908 was reported by the smelters as 2,240 tons.

PRODUCTION OF LEAD PIGMENTS.

In addition to the leaded zinc oxide and zinc-lead oxide pigments, which are noted more particularly in connection with the production of zinc pigments, there are two lead pigments which are produced directly from ore, namely, sublimed white lead and sublimed blue lead, and a third one, litharge, is sometimes so produced. Sublimed white lead consists of lead sulphate 75 per cent, lead oxide 20 per cent, and zinc oxide 5 per cent. Sublimed blue lead consists of lead sulphate 50–53 per cent, lead oxide 38–41 per cent, with small proportions of lead sulphide, lead sulphite, and zinc oxide. Litharge, lead

monoxide, is generally manufactured from pig lead, but the quantity given below was made directly from ore. The production of leaded zinc oxide and zinc-lead oxide is repeated here for convenience.

Production of lead pigments in 1907 and 1908, in short tons.

	1907.	1908.
Sublimed white lead	8,700	9,100
Sublimed blue lead	1,211	1,311
Litharge	1,214	918
Leaded zinc oxide	13,516	8,430
Zinc-lead oxide		
Lead content of these pigments	7,099	8,277

PRODUCTION OF SECONDARY LEAD.

Important sources of lead are skimmings, drosses, old metal, and alloys, as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral portion of the lead industry. This business is mostly carried on at small refineries scattered over the United States, but the large smelters and refineries working primary lead frequently find it advantageous to incorporate material from secondary sources. In such cases it has been noted on the reports of the smelters to the Survey, and to that extent the production of secondary lead has been heretofore taken into account. In the preparation of the present report the attempt was made to reach as many as possible of the refiners working on secondary material. It is not to be supposed that the effort was completely successful, but returns from 44 of the more important refineries of secondary lead are embodied in the table below. The product of such refineries is of two classes, pig lead and lead in alloys. In the latter case the lead may have been recovered in the form of pig lead and alloyed at the refinery or it may have been refined as an alloy, being brought to the desired composition by addition of the requisite metal.

Production of secondary lead in the United States in 1907 and 1908, in short tons.

	1907.	1908.
Pig lead	9,990	7,990
Lead in alloys	15,508	10,543
Total recovered lead	25,498	18,533

COMPARISON OF STATE TOTALS BASED ON SMELTER RETURNS AND ON MINE REPORTS.

The foregoing figures of the production of metallic lead by the respective States are compiled from reports of individual lead smelters and refineries. For several years the production of the more valuable metals in the Western States has been obtained by the Survey from reports of individual mines. In 1906 the same method was followed in the Atlantic States, and in 1907 the plan was extended to take in the whole country. In order to put the smelter production on the same basis as the mine figures, all the lead which was produced as pigments directly from ore is added to the production of metallic lead. The lead recovered from secondary sources is excluded

from these totals, since it has already been reckoned once as pig lead. These facts must be borne in mind in comparing this table with the preceding tables. The state totals obtained by each method are compared in the following table:

Comparison of state totals compiled from smelter and mine returns, 1907–8, in short tons.

State.	1907.				1908.			
	Totals based on smelter reports.	Totals based on mine reports.	Differences.		Totals based on smelter reports.	Totals based on mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Alaska					3		3	
Arizona	2,350	2,330	20		1,464	1,504		40
Arkansas	15	12	3			15		15
California	854	1,313		459	515	619		104
Colorado	50,596	42,703	7,893		30,852	26,100	4,752	
Idaho	112,569	116,912		4,343	98,464	103,414		4,950
Illinois	509	830		321	363	399		36
Iowa	225	242		17	110	51	59	
Kansas	1,929	2,555		626	2,825	2,518	307	
Kentucky	75	34	41					
Missouri	127,373	138,675		11,302	127,620	144,459		16,839
Montana	2,035	1,874	161		2,320	2,298	22	
Nevada	3,380	3,136	244		3,796	3,623	173	
New Mexico	2,126	1,905	221		586	437	149	
Oklahoma	476	532		56	1,577	1,781		204
Oregon					7	1	6	
South Dakota					13	12	1	
Tennessee	16	0	16					
Texas	10	12		2	42	33	9	
Utah	62,073	57,969	4,104		42,455	44,389		1,934
Virginia	[a] 84	[a] 70	14		13	38		25
Washington	346	410		64	593	575	18	
Wisconsin	3,551	3,499	52		4,107	4,138		31
	370,592	375,013			317,725	336,404		

[a] Includes, also, production of Georgia and New Hampshire.

The smelter totals represent actual recovery and are found by summing up the total production reported by all companies for each State, respectively, and recalculating all pigments back to equivalent metallic lead on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of lead ores and concentrates shipped, and from this tonnage the lead content is reckoned by assay value. The quantities thus obtained from all the producing properties in each State are combined to make the total for that State. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content be correctly estimated.

With equal conditions affecting the mines and the smelters, the stocks in the ore bins of the smelters should run about even from year to year, and the mine and smelter state totals, making allowance in the former for losses in smelting, should show reasonable agreement. As may be seen from the table, however, there are frequent discrepancies. The causes of these discrepancies fall into four categories. The first is lag, by which is meant the time that elapses between the shipment of ore by the mine and the reduction of the ore by the smelter. This is frequently considerable, for ore raised near the end of the year may remain in the stock bins of the smelter

or of the refinery until the succeeding year and, unless balanced by an equivalent lag from the preceding year, will thus lead to an apparent "mine excess." If through accident, business depression, or otherwise, the mines close down, the smelters largely consume their ore stocks, which results in an apparent "smelter excess." The second source of difference is found in error in the mine totals, either in ore tonnage or in the arbitrary calculation of metal content from assay. The dry assay in vogue in the Western States gives results uniformly too low. A decision of the United States circuit court (T. D. 21653) recognizes a differential of 1.5 per cent between the dry assay and chemical analysis. A third source is found in failure of the smelter returns to segregate accurately the ore from the different States. Until 1906 the ore coming from the Joplin districts was lumped by the smelters as from Missouri or Missouri-Kansas, though some of it was from Oklahoma. This made a smelter excess for Missouri and a mine excess for Kansas and Oklahoma. The same custom was to a certain extent true of the upper Mississippi Valley district. Though apportioned to the proper States since 1906, the division is confessedly a rough estimate in the case of some of the smelters which do not keep the ore from these regions separate on their books. Lastly, there is not taken into account in these totals the loss in smelting, ranging from 2 per cent in the case of the better-ordered smelters to 5 per cent or more in the smaller soft-lead smelters or those running on very refractory ores. Lag being left out of account, each State would normally show a small mine excess equal to this smelting loss. Any discrepancy which appears in the table may reasonably be ascribed to one or more of these items. In the long run, barring error and allowing for smelting losses and exportation of ore, the "mine excess" will be balanced by equivalent "smelter excess."

SMELTER AND MINE STATE TOTALS.

In most cases the totals agree reasonably well, but in a few cases it may be well to point out the causes of the disparity. In Colorado there has been a smelter excess for the last two years which, barring error, must be due to depletion of stocks of Colorado ores in the smelters and of Colorado bullion in the refineries. The mine excess in Idaho is no doubt due to smelting losses. Smelter excesses in Iowa and Kansas are offset by mine excesses in 1907 and are apparently due to lag. In Missouri the mine excess in 1907 and 1908 is in part accounted for by smelting loss and in part by lag of the smelter excess of 1906. There has been a small smelter excess in Montana for three successive years. The records of this office do not go back far enough to show whether there was a previous mine excess to draw from. Smelter excesses in Nevada and New Mexico in both 1907 and 1908 are partly explained by a mine excess in 1906. The mine excess in Utah is due to smelting loss.

REDUCTION.

In methods of ore dressing progress has largely been directed toward improvements in treating the complex sulphide ores of lead and zinc. Considerable space in the chapter on zinc in this volume has been devoted to a review of recent developments in the treat-

ment of such ores, in particular to the present status of the flotation processes, and the reader is referred to that report for details.

In the metallurgy of lead there have been no novel developments during the year. The smelting of lead is an old and well-established practice. The notable improvements in recent years have been the introduction of "pot" or "blast" roasting and the installation of bag houses, the latter greatly increasing the recovery, especially when used with the Scotch hearth. "Blast" roasting has various advantages, such as reducing the loss of lead and silver, giving better desulphurization, yielding a sintered product which increases the capacity of the blast furnace, and greatly reducing the danger from lead poisoning. To the Huntington-Heberlein, the Carmichael-Bradford, and the Savelsberg processes, in which the blast roasting is done in large pots, there has lately been added the Dwight and Lloyd process, in which the moistened charge is spread in a sheet upon the porous face of a slowly revolving drum through a certain area of which an air blast is drawn. Ignited by a burner, the charge, in passing over the area of the blast, is roasted and sintered and then mechanically stripped from the drum.

The Tintic Smelting Company completed a new smelter near Silver City, Utah. It is furnished with 4 water-jacketed lead blast furnaces, 48 by 160 inches in size, having a capacity of 250 tons each, and 1 water-jacketed copper blast furnace of 250 tons capacity, together with appropriate sampling and roasting equipment. Two lead furnaces were started up late in 1908, and a third one early in 1909, the fourth being held in reserve for the present.

The Panhandle smelter at Ponderay, Idaho, was taken over by the Idaho Smelting and Refining Company during 1908. To the original 125-ton furnace another of similar capacity was added and 3 more roasting furnaces were installed, as well as other improvements. The remodeled smelter was blown in late in October, 1908.

The smoke problem, in relation to lead and copper smelters, reached a more acute stage during the year, and lead smelters were in some cases compelled to discontinue operations for an interval. The Selby smelter was ordered closed by the California courts pending the installation of a fume-precipitation plant. The United States Smelting Company has installed in its plant at Bingham Junction, Utah, a zinc-oxide neutralizing process and added a bag house.

RESOURCES.

It has been customary in these reports to give a summary of mining developments during the year in each of the main lead-producing States, together with an outline description of the main producing districts or properties. Since 1907 the mine reports, to be found in another part of this volume, have covered every State which produces either gold, silver, copper, lead, or zinc. In those mine reports, under each State, will be found a much more complete review than it would be expedient to give at this place.

A source of lead, the importance of which justifies a word in this connection, is one which is generally overlooked in considering the resources of the country, namely, lead recovered from secondary materials. The supply of such lead during 1907 was 25,498 short tons, and during 1908 it was 18,333 tons, outputs exceeded by the lead production of but four States during those years.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

The following table of the production of lead in the world has been calculated from the statistics published by the Metallgesellschaft, the Metallurgische Gesellschaft A.-G., and the Berg- und Metallbank, Aktiengesellschaft, of Frankfurt-am-Main, Germany, with the exception of the substitution of the figures collected by the Geological Survey for the production of the United States. It is to be noted that the production of Central and South American countries is not included in the table. As shown on a preceding page, considerable lead has been smelted and refined in the United States in the last three years from ores produced in those countries. Noteworthy gains in production were made by Australia, Germany, and especially by Mexico; the largest loss was shown by the United States.

The world's production of lead, 1904–1908, in short tons.

Country.	1904.	1905.	1906.	1907.	1908.
Australia	131,615	117,946	102,514	106,923	131,376
Austria-Hungary	14,440	14,881	18,078	16,975	16,118
Belgium	25,904	25,243	24,471	28,417	33,231
Canada	18,960	28,329	26,235	23,778	23,846
France	20,723	26,565	28,219	25,353	27,600
Germany	151,676	168,211	166,117	157,156	181,167
Great Britain	26,896	25,684	26,455	30,203	33,120
Greece	16,755	15,102	13,338	15,212	17,664
Italy	25,904	21,054	23,479	25,243	28,704
Japan	1,984	2,535	3,858	3,858	3,312
Mexico	92,483	82,673	59,524	79,366	121,440
Russia	331	331	331	110	110
Spain	195,989	199,186	199,406	204,848	202,253
Sweden	661	661	882	772	883
Turkey in Asia	11,795	11,464	10,582	11,464	13,027
Other countries	331	220	220	220	552
United States	307,000	302,000	350,153	365,166	310,762
Total	1,043,447	1,042,085	1,053,862	1,095,064	1,145,165
United States percentage of world's production	29.5	29.0	33.2	33.3	27.1

IMPORTS AND EXPORTS.

The following figures of imports and exports of lead are taken from the records of the Bureau of Statistics of the Department of Commerce and Labor:

Lead imported and entered for consumption in the United States, 1900–1908, in pounds.

Year.	Lead in ore.		Pigs, bars, and old.		Sheets, pipe, and shot.		Not otherwise specified.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1900	10,209,742	$623,802	3,673,616	$76,141	27,945	$1,393	$877	$702,213
1901	10,324,119	272,396	3,604,157	88,056	56,735	2,773	1,234	364,459
1902	14,499,339	316,005	12,443,615	319,035	224,209	7,765	5,258	648,063
1903	41,155,130	716,128	8,972,635	255,135	17,008	810	1,589	973,662
1904	19,015,540	328,279	17,334,033	480,823	69,581	2,441	5,277	816,820
1905	49,526,990	784,548	10,379,753	329,209	77,668	3,813	1,139	1,118,709
1906	[a]44,560,258	[a]755,545	24,882,983	960,998	346,177	17,250	4,503	[a]1,738,296
1907	[b]13,363,875	[b]286,802	15,667,170	718,198	734,418	39,210	3,450	[b]1,047,641
1908	[c]2,806,524	[c]76,746	5,346,290	176,363	42,377	2,026	9,843	[c]264,978

[a] Exclusive of 587,731 pounds of base bullion, valued at $15,635.
[b] Exclusive of 1,196,224 pounds of base bullion, valued at $35,303.
[c] Exclusive of 11,415,463 pounds of base bullion, valued at $251,266.

Imports of lead, in ore, base bullion, and refined, by countries, 1903–1908, in pounds.

Country.	1903.	1904.	1905.	1906.	1907.	1908.
United Kingdom	1,552,772	494,556	1,589,859	9,852,760	433,971	399,569
Germany	1,409,926	731,222	250,241	2,006,369	456,649	695,151
Other European countries	451,331	165,661	117,699	3,920,313	6,922,276	1,699,509
Total from Europe	3,414,029	1,391,439	1,957,799	15,779,442	7,812,896	2,794,229
British North America	19,200,806	17,903,798	16,362,916	18,514,244	13,272,900	1,291,044
Mexico	186,136,779	205,805,911	175,167,694	133,512,526	137,543,692	219,567,193
South America	3,895,536	579,918	3,154,483	315,265	883,355	469,770
Other countries	166,336	22,246	112,516	147,462	116,868	26,418
Total imports	212,813,486	225,703,312	196,755,408	168,268,939	159,629,711	224,148,654

In the foregoing table, 98 per cent of the imports of lead from Europe in 1907 were in the form of refined lead, and 90 per cent of the imports from all other countries consisted of ore and base bullion. In 1908, on the contrary, 75 per cent of the imports from Europe consisted of ore and base bullion, and 98 per cent of the imports from other countries were likewise of ore and base bullion.

The following table shows the imports of lead in ore, base bullion, and pigs, bars, sheets, and old, for the years 1907 and 1908:

Imports of lead, by classes, 1907 and 1908, in pounds.

	1907.	1908.
Lead in ore	64,815,254	64,709,104
Base bullion	76,259,828	153,864,329
Pigs, bars, sheets, and old	18,554,899	5,518,619
Total	159,629,981	224,092,052

Lead, and manufactures of lead, of domestic production, exported, 1900–1908, in pounds.

Year.	Manufactures of lead.		Pigs, bars, and old.		Total value.
	Quantity.	Value.	Quantity.	Value.	
1900	[a] 363,600	[b] $130,758 [c] 240,149	1,993,773	$88,664	$459,571
1901	[a] 490,460	[b] 178,752 [c] 230,940	4,787,107	214,842	624,534
1902	[a] 454,423	[b] 153,309 [c] 256,153	6,542,760	286,548	696,010
1903	[a] 364,220	[b] 127,530 [c] 357,622	112,544	6,210	491,362
1904	[a] 439,953	[b] 160,863 [c] 451,785	70,408	3,478	616,126
1905	[a] 445,002	[b] 156,162 [c] 506,076	125,332	5,623	667,861
1906	[a] 505,750	[b] 175,719 [c] 590,992	147,551	9,065	775,776
1907	[a] 728,975	[b] 269,982 [c] 679,000	110,104	7,096	956,078
1908	[a] 482,330	[b] 177,710 [c] 599,640	[d]	.....	777,350

[a] Type.
[b] Value of type.
[c] Value of all other manufactures.
[d] Included in all other manufactures.

CUSTOMS DUTIES.

The tariff of 1909 made a slight change in the duty on lead pipe, sheets, shot, wire, etc., and a very important change in the section regulating the smelting and refining of lead in bond. Under the tariff of 1897 the customs bond was canceled upon the exportation of 90 per cent of the weight of base bullion or lead contents of ore imported. Under the present tariff the bond is canceled only upon the exportation of the actual quantity of lead produced from the base bullion and ore. The sections of the new tariff which are concerned with lead and lead products are as follows:

181. Lead-bearing ore of all kinds, one and one-half cents per pound on the lead contained therein: *Provided*, That on all importations of lead-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

182. Lead dross, lead bullion or base bullion, lead in pigs and bars, lead in any form not specially provided for in this section, old refuse lead run into blocks and bars, and old scrap lead fit only to be remanufactured; all the foregoing, two and one-eighth cents per pound; lead in sheets, pipe, shot, glaziers' lead and lead wire, two and three-eighths cents per pound.

191. Type metal, one and one-half cents per pound on the lead contained therein.

49. Red lead, two and five-eighths cents per pound.

53. White lead, and white pigment containing lead, dry or in pulp, or ground or mixed with oil, two and one-half cents per pound.

58. Lead: Acetate of, white, three cents per pound; brown, gray, or yellow, two cents per pound; nitrate of, two and one-fourth cents per pound; litharge, two and one-half cents per pound.

Sec. 24. That the works of manufacturers engaged in smelting or refining, or both, of ores and crude metals, may upon the giving of satisfactory bonds be designated as bonded smelting warehouses. Ores or crude metals may be removed from the vessel or other vehicle in which imported, or from a bonded warehouse, into a bonded smelting warehouse without the payment of duties thereon and there smelted or refined, or both, together with other ores or crude metals of home or foreign production: *Provided*, That the several charges against such bonds may be cancelled upon the exportation or delivery to a bonded manufacturing warehouse, established under section twenty-three of this act, of the actual amount of lead produced from the smelting or refining, or both, of such ores or crude metals: *And provided further*, That said lead may be withdrawn for domestic consumption or transferred to a bonded customs warehouse and withdrawn therefrom upon the payment of the duties chargeable against it in that condition: *Provided further*, That all labor performed and services rendered pursuant to this section shall be under the supervision of an officer of the customs, to be appointed by the Secretary of the Treasury, and at the expense of the manufacturer: *Provided further*, That all regulations for the carrying out of this section shall be prescribed by the Secretary of the Treasury.

CONSUMPTION.

In previous statements of lead consumption in these reports it has been the custom to take into account the smelter stocks of lead at the beginning and at the close of the year. It is not to be denied that for the individual year this gives closer figures. It is just as true

that account of trade stocks should also be taken to arrive at accurate results; but this is manifestly outside the scope of this bureau. It has been found impossible to obtain a statement of stocks from one large producer in either 1907 or 1908; hence consumption has been calculated without reference to domestic stocks. A very considerable part, however, amounting in 1908 to nearly one-fourth of the lead smelted and refined in this country, is of foreign origin smelted in bond, and it is possible to obtain the stocks of this portion since they are reported annually by the Bureau of Statistics as "merchandise remaining in warehouse at close of year." A certain element of error is introduced by the fact that the imports, the exports, and the warehouse stocks, as given, include both lead in ore and base bullion. So far as imports are concerned, the relative quantities of lead in ore and of base bullion are shown in the table on a preceding page, entitled "Imports of lead, by classes," based upon the records of the Bureau of Statistics, and corroborated in the preceding table giving the "Sources of primary lead smelted or refined in the United States," based upon smelter reports. For exports and stocks no such division can be made. Nevertheless, it is deemed advisable to use warehouse stocks as giving a better estimate of consumption. It is necessary, therefore, to include all classes of lead imports as well as all classes of lead exports.

In the following table "lead" includes all kinds—lead in ore, base bullion, pigs, bars, and old. The figures of domestic production are based upon returns by the smelters; all other figures are from the records of the Bureau of Statistics. Decrease by liquidation covers losses in smelting and refining in bond and other corrections. Warehouse stocks of bonded lead of foreign origin are given, but it has been found impossible to obtain complete figures of domestic stocks for 1907 and 1908. For this reason the result given below is lead "available for consumption." The "apparent consumption" of previous reports would be this quantity increased or diminished by the increase or decrease of domestic stocks during the year, and also diminished by the exports of domestic lead. The domestic lead exports consist of lead in manufactures and in type, as shown in a preceding table.

Consumption of primary lead in the United States, in short tons.

	1907.	1908.
Supply—		
Stock in bonded warehouses January 1	5,756	12,944
Imports—		
For consumption	15,246	9,805
For warehouse	64,569	102,241
Production from domestic ores	365,166	310,762
Total supply	450,737	435,752
Withdrawn—		
Exports of foreign lead	51,447	76,357
Exports of foreign lead in manufactures under drawback	8,628	9,254
Decrease by liquidation	4,578	13,425
Stock in bonded warehouses December 31	12,944	18,565
Total withdrawn	77,597	117,601
Available for consumption	373,140	318,151

For facility of comparison of consumption in the United States with that of the world, the consumption of the former has been calculated with and without stocks for a period of ten years, as shown in the following table. Consumption of lead, as shown in the second column, means the production of refined lead plus excess of exports over imports or minus excess of imports over exports. Additions made to stock during the year will thus appear as consumed, but as such stocks are apt to go into the market within the next year and cut down the apparent consumption to that extent, they thus compensate in the long run, leaving an accurate average measure of the consumption. The statistics of consumption of foreign countries as given in the table are taken from the estimates of the Metallgesellschaft, etc., which are also compiled without regard to stocks. In the following table, the first column gives, for the sake of comparison, the consumption with stocks taken into consideration; the remainder of the table disregards stocks. In neither column showing the United States consumption is the production of secondary lead taken into account.

World's consumption of pig lead, exclusive of secondary lead, 1898–1908, in short tons.

Year.	Stocks considered.	Stocks disregarded.			
	United States.	United States.	Foreign countries.	Total world's consumption.	United States, percentage.
1898	227,452	225,177	651,018	876,195	25.70
1899	226,315	230,294	652,782	883,076	26.08
1900	269,302	279,172	667,002	946,174	29.50
1901	271,934	284,126	663,805	947,931	29.97
1902	332,484	300,643	685,079	985,722	30.50
1903	300,167	284,556	701,945	986,501	28.85
1904	319,543	320,330	719,471	1,039,801	30.81
1905	347,015	343,682	736,998	1,080,680	31.80
1906	376,337	376,981	703,378	1,080,359	34.89
1907	[a] 373,140	386,351	697,205	1,083,556	35.66
1908	[a] 318,151	336,792	807,024	1,143,816	29.44

[a] See preceding table, "Consumption of primary lead in the United States" in 1907–8.

Consumption of lead, stocks and secondary lead disregarded, in 1906–1908, by countries, in short tons.

Country.	1906.	1907.	1908.
Australia	4,960	5,952	8,501
Austria-Hungary	26,235	27,778	31,906
Belgium	25,022	34,723	22,963
Canada	17,416	15,983	17,664
France	94,688	89,397	113,712
Germany	214,838	206,130	233,277
Great Britain	213,956	214,287	252,593
Holland	5,512	5,732	5,961
Italy	33,400	33,290	40,296
Japan	15,983	15,983	8,833
Russia	27,558	27,668	49,348
Switzerland	5,842	5,842	6,514
Other European countries	3,307	3,417	4,416
Other countries	14,661	11,023	11,040
United States	376,981	386,351	336,795
	1,080,359	1,083,556	1,143,816

USE OF LEAD IN THE UNITED STATES.

The United States Geological Survey does not collect statistics of the use of lead. The following table is from figures published in the Engineering and Mining Journal, which purport to cover about 90 per cent of the total consumption:

Use of lead in the United States, 1907 and 1908.

	1907.		1908.	
	Quantity.	Percentage.	Quantity.	Percentage.
	Short tons.		*Short tons.*	
White lead and oxides	115,000	34.8	117,500	40.5
Pipe	41,000	12.4	33,800	11.6
Sheets	21,500	6.5	16,400	5.7
Shot	28,000	8.5	31,600	10.9
Other purposes	125,238	37.8	90,700	31.3
	330,738	100.0	290.000	100.0

PRICES.

Under the influence of large stocks of lead in the hands of the producers and allied interests, the year 1908 opened with lead at 3.55 to 3.60 cents per pound. With returning confidence, the increased activity of the building trades reacted upon the lead market, which showed a steady appreciation in prices that culminated near the middle of August with lead at 4.575 to 4.625 cents per pound. The rise in prices had already stimulated the resumption of western production, which now began to reach the market. There followed a decline in prices, which continued to the end of the year, closing with lead at 4.15 to 4.20 cents per pound. The yearly average was 4.2 cents.

The London lead market exhibited considerable variation from the New York market, opening with £14 15s. per long ton (3.20 cents per pound) for Spanish lead, and declining steadily until late June, when the minimum for the year was reached at £12 6s. 3d. per long ton (2.67 cents per pound). For the last half of the year prices remained nearly level, closing at £13 per long ton (2.82 cents per pound). The yearly average price was £13 10s. 5d. (2.94 cents per pound).

In the following table are shown the highest and the lowest prices of lead at New York in each month during the last eight years. All figures for prices are in cents per pound. Those for 1906 and later are based upon daily quotations published in the Engineering and Mining Journal and those for preceding years on quotations published in the Iron Age.

Highest and lowest prices of lead at New York City, monthly, 1901–1908, in cents per pound.

Year.	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½
1902	4.10	4.00	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.10	4.05	4.10	4.05	4.65	4.10	4.65	4.35
1904	4.50	4.25	4.50	4.40	4.60	4.50	4.60	4.50
1905	4.60	4.45	4.50	4.45	4.50	4.45	4.55	4.50
1906	5.60	5.60	5.60	5.35	5.35	5.35	5.50	5.35
1907	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1908	3.80	3.55	3.75	3.70	4.00	3.65	4.10	3.90

Highest and lowest prices of lead at New York City, monthly, 1901–1908, in cents per pound—Continued.

Year.	May.		June.		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½
1902	4.10	4.05	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.35	4.30	4.35	4.10	4.10	4.05	4.10	4.05
1904	4.50	4.25	4.35	4.20	4.30	4.10	4.20	4.10
1905	4.55	4.50	4.55	4.50	4.60	4.50	4.85	4.60
1906	5.75	5.50	5.75	5.75	5.75	5.75	5.75	5.75
1907	6.00	6.00	6.00	5.75	5.75	5.25	5.25	5.25
1908	4.37½	4.05	4.52½	4.32½	4.52½	4.40	4.62½	4.47½

Year.	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1901	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.37½	4.00
1902	4.10	4.05	4.10	4.05	4.10	4.05	4.10	4.05
1903	4.40	4.10	4.40	4.35	4.40	4.10	4.25	4.10
1904	4.25	4.20	4.30	4.20	4.50	4.20	4.65	4.60
1905	4.90	4.85	5.30	4.85	5.40	5.15	5.90	5.25
1906	5.75	5.75	5.75	5.75	5.75	5.75	6.00	5.75
1907	5.25	4.75	4.75	4.75	4.75	4.00	4.10	3.35
1908	4.60	4.52½	4.47½	4.20	4.40	4.25	4.30	4.12½

THE LEAD CONVENTION.

It is reported that an organization of lead producers was formed early in 1909, at Paris, with the purpose of steadying prices by the control of lead sales. Those indicated as concerned are a group of German lead interests, chiefly metal sellers, the Broken Hill Proprietary Company (Limited), of Australia, and certain producing interests in the United States which handle Mexican lead. The combination, as organized at present, is said to control about 45 per cent of the world's production of lead. It is expected that ultimately the convention will include all important European producers and Mexican producers.

THE CANADIAN LEAD BOUNTY.

For the five years between July 1, 1903, and June 30, 1908, the Dominion government has granted a bounty on the lead contents of ores mined in Canada. The bounty amounts to 75 cents per 100 pounds of lead content when the London price of lead does not exceed £12 10s. per long ton (2.7 cents per pound). With increase in the price of lead the bounty decreases at the same ratio until at about £16 per long ton (3.5 cents per pound) it ceases. The payment of bounties is not to exceed $500,000 in any one year.

At the expiration of the five-year period, June 30, 1908, the bounty was extended for a second period of five years, with a slight change in the standard prices of lead upon which the bounty is based. The upper limit at which the full bounty is paid is now £14 10s. per long ton (3.15 cents per pound). Above this figure the bounty decreases pro rata until it is extinguished at about £18 per long ton (3.91 cents per pound).

The effect of the bounty is to maintain to the producer a steady value for lead. This figure under the first period of operation of the bounty was, of course, £16 per long ton, and under the new bounty will be £18 per long ton. The operation of the bounty has greatly stimulated the production of lead during the five-year period, the total bounty paid being $712,000.

SUMMARY.

The following tabular statement gives the general items regarding domestic and world production and consumption. The figures for domestic items are those compiled by this office, and the figures for the world items are based upon statistics compiled by the Metallgesellschaft, etc.

Summary of lead statistics, 1907 and 1908, in short tons.

	1907.	1908.
Production of refined lead in the United States	414,189	396,433
Production of desilverized lead in the United States	314,241	265,564
Production of soft lead in the United States	129,607	130,882
Production of antimonial lead in the United States	9,910	13,629
Total production of lead from domestic ores	365,166	310,762
Production of secondary lead in the United States	25,498	18,533
Consumption of lead in the United States (disregarding stocks)	386,351	336,792
World production (approximate)	1,095,064	1,145,165
World consumption (approximate)	1,083,556	1,143,816
United States percentage of world production	33.3	27.1
United States percentage of world consumption	35.6	29.4
World rank of United States in production of lead	First.	First.
World rank of United States in consumption of lead	First.	First.

ZINC.

By C. E. Siebenthal.

INTRODUCTION.

An estimate of the production of spelter in 1908 was given out in the form of a press bulletin on January 1, 1909. This estimate was based on reports from every smelter which gave the actual production for the first eleven months of 1908, with an estimate of the production for December. The total thus obtained varied a little over 1 per cent from the final figures of production. The complete figures of production and consumption of spelter, of imports and exports of spelter and zinc ore, and of production of secondary spelter were given in the advance statement of spelter production published on February 27, 1909. The present report contains in addition the production of various zinc pigments, a comparison of the mine and the smelter production of zinc by States, and a summary of metallurgical advance and of trade conditions for the year. The statistics of production in this country are based upon confidential returns to the Survey by each zinc-smelting company in operation during the year. The statistics of domestic consumption are taken in part from these smelter returns and in part from the records of the Bureau of Statistics of the Department of Commerce and Labor, and the tables for foreign production and consumption are compiled from the sources indicated.

The collection of the figures of mine production in the Central States in 1907 and 1908 allows a comparison of smelter and mine state totals for all zinc-producing States for two years in succession, thus to a certain extent eliminating the lag in smelting and affording a truer comparison.

STATE OF ZINC INDUSTRY IN 1908.

The year was a hard one on the zinc-smelting industry; it began with low prices and probably the largest stocks in the history of the industry in this country. Conditions improved during the first quarter, but by the middle of the year were back at the point of beginning. The latter half of the year was marked by gradual improvement. The average number of retorts in operation during the year is estimated by Mr. A. B. Cockerill [a] at about 56,500, or 60 per cent of a total of 93,958. Spelter stocks were reduced during that time about 25 per cent. Owing to the reduced output for 1908, the United States lost first place in the world's production, Germany, with the combined product of Silesia and the Rhine district, again taking that position.

[a] Personal communication.

The zinc-mining industry reflected the conditions prevailing in the smelting industry. Some companies which might have operated at a small profit frankly refused to sell ore at the market rates and closed down. Others ran intermittently and stored the ore. At the close of the year [a] there was unsold in the ore bins in the Joplin region over 6,000 tons of blende concentrates. Many of the large mines in this district, especially in the sheet-ground area, which were closed down in the latter part of 1907, remained closed through 1908. The total production of zinc concentrates in the Joplin region fell off 21,809 tons, or 7.8 per cent, from the production of 1907. The Franklin Furnace mine, of New Jersey, and the upper Mississippi Valley region held their own in production in 1908, but the zinc production of Colorado fell off nearly 50 per cent.

PRODUCTION.

The production of spelter in the United States began in 1858 in an experimental way,[b] and regular production began in 1860 at the Lehigh Zinc Works in the East and at the Matthiesson & Hegeler works in the West. Between 1864 and 1870 nine or ten other zinc smelters were established. Statistics of production are recorded for the years 1873 and 1875, and for the census year ending May 31, 1880. Annual statistics have been collected by the United States Geological Survey since 1882. The output for 1908 of primary [c] spelter (crude metallic zinc) in the United States from domestic ores was 190,749 short tons; from foreign ores 19,675 short tons, a total of 210,424 short tons. This production shows a decrease of 39,436 tons, or 15.8 per cent, from that of 1907. The annual progress of the zinc-smelting industry since 1873 is shown in the following table:

Annual production of spelter in the United States from domestic and foreign ores, 1873–1908, in short tons.

Year.	From foreign ore.	From domestic ore.	Total.
1873		7,343	7,343
1875		15,833	15,833
1880		23,239	23,239
1882		33,765	33,765
1883		36,872	36,872
1884		38,544	38,544
1885		40,688	40,688
1886		42,641	42,641
1887		50,340	50,340
1888		55,903	55,903
1889		58,860	58,860
1890		63,683	63,683
1891		80,873	80,873
1892		87,260	87,260
1893		78,832	78,832
1894		75,328	75,328
1895		89,686	89,686
1896		81,499	81,499
1897		99,980	99,980
1898		115,399	115,399
1899		129,051	129,051
1900		123,886	123,886
1901		140,822	140,822

[a] According to figures kindly furnished by the Producers' Information Bureau, of Webb City, Mo.

[b] Ingalls, W. R., Lead and Zinc in the United States, p. 314.

[c] In Mineral Resources for 1906, p. 461, zinc derived from ore was called "primary" spelter to distinguish it from the secondary spelter recovered from such sources as drosses, skimmings, and old metal. The former has also been called "virgin" spelter, and the latter has been called "remelted," "reclaimed," and "dross" spelter. The distinctive origin is more plainly suggested by the terms "primary" spelter and "secondary" spelter, and they will be used hereinafter. Where the word "spelter" is used without qualification primary spelter will be understood.

Annual production of spelter in the United States from domestic and foreign ores, 1878–1908, in short tons—Continued.

Year.	From foreign ore.	From domestic ore.	Total.
1902	.....	156,927	156,927
1903	.....	159,219	159,219
1904	.....	[a] 186,702	186,702
1905	.....	[a] 203,849	203,849
1906	25,076	199,694	224,770
1907	26,115	223,745	249,860
1908	19,675	190,749	210,424

[a] Including an unknown quantity smelted from foreign ore, small in 1904 but larger in 1905.

PRODUCTION BY STATES.

Two tabulations of the spelter production of the country in 1908 are given below, one showing the locality from which the ores were derived, the other the locality in which they were smelted. Each method has its special interests and advantages, depending on whether the view point be that of producer or consumer, or that of resources.

These state totals are compiled entirely from confidential reports by each zinc-smelting company in operation in the United States in 1908. Only primary spelter is here included, the recovery of secondary spelter being given in a later table.

The following table shows the sources of all ores and concentrates smelted for zinc in the United States in 1908 and the quantity of zinc actually derived from the ores from these respective sources:

Production of primary spelter in the United States in 1906–1908, apportioned according to source of ore, in short tons.

Source.	1906.		1907.		1908.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Arizona	64	0.032	77	0.03	152	0.08
Arkansas	1,801	.90	1,911	.85	2,002	1.05
California	.....	.....	140	.06	27	.01
Colorado	32,456	16.25	26,077	11.66	24,885	13.05
Idaho	573	.29	3,508	1.57	581	.30
Illinois	282	.14	1,446	.65	298	.16
Iowa	201	.10	220	.10	516	.27
Kansas	3,902	1.96	13,850	6.19	8,628	4.52
Kentucky	335	.17	358	.16	341	.18
Maine	.....	.....	1	.0004	.....	.....
Missouri	130,348	65.27	141,824	63.39	123,655	64.83
Montana	1,415	.71	.....	.....	900	.47
Nevada	1,768	.88	1,692	.76	398	.21
New Jersey	11,206	5.61	13,573	6.07	6,926	3.63
New Mexico	555	.28	136	.06	134	.07
Oklahoma	.....	.....	719	.32	2,235	1.17
Tennessee	124	.06	181	.08	341	.18
Texas	8	.004	16	.0007	.....	.....
Utah	2,449	1.23	1,972	.88	282	.15
Virginia	1,143	.57	771	.34	910	.48
Washington	7	.004	.....	.....	.....	.....
Wisconsin	11,057	5.54	15,273	6.83	17,538	9.19
Total from domestic ores	199,694	100.00	223,745	100.00	190,749	100.00
Foreign:						
British Columbia	201	.80	545	2.09	2,425	12.33
Mexico	24,875	99.20	25,570	97.91	17,250	87.67
Total from foreign ores	25,076	100.00	26,115	100.00	19,675	100.00
Grand total	244,770	.....	249,860	.....	210,424	.....

The subjoined table is designed to show the localities in which spelter was made.

Production of spelter in the United States, 1902–1908, apportioned according to locality in which smelted, in short tons.

	1902.	1903.	1904.	1905.	1906.	1907.	1908.
Illinois	[a] 47,096	[a] 47,659	47,740	46,606	47,939	56,056	50,244
Kansas	86,564	88,388	107,048	114,287	129,564	134,108	99,298
Missouri	11,087	9,994	12,150	11,844	11,077	11,732	10,201
Oklahoma	.....	.....	.....	.....	.....	5,035	14,864
Other States [b]	12,180	13,178	19,764	31,112	36,190	42,929	35,817
Total	156,927	159,219	186,702	203,849	224,770	249,860	210,424
Secondary spelter included	2,675	3,302	3,300	1,469	.....	.....	.....
Total primary spelter	154,252	155,917	183,402	202,380	224,770	249,860	210,424

[a] Includes Indiana.
[b] Includes New Jersey, Pennsylvania, Virginia, West Virginia, and Colorado.

ZINC PIGMENTS.

There are four white pigments which have zinc for a base, either in whole or in part, namely, zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. All of these may be, and the first three usually are, made directly from ore.

Zinc oxide is the most important of these pigments. In European practice the oxide is made from spelter, but in this country it is generally made directly from the ores, though in 1908 of the whole production 2,374 tons was made from spelter. The production of zinc oxide in the United States fell off greatly in 1908, being 57,237 short tons (including that made from Mexican ore), as compared with 71,784 short tons in 1907, a decrease of 14,544 tons, or over 20 per cent. The imports of zinc oxide in 1908 were 2,423 tons and the exports for the same period were 12,008 tons.

Leaded zinc oxide and zinc-lead oxide are produced from ore, both in some cases at the same plant, the zinc-lead containing somewhat the larger percentage of lead. The combined production of these two pigments in 1908 was 8,430 tons, as compared with 13,516 in 1907.

Lithopone is an intimate mixture by chemical precipitation of zinc sulphide and barium sulphate. It is now generally manufactured from spelter or zinc oxide, but may also be made from scrap zinc, zinc skimmings, etc.

The total production of zinc and zinc-lead pigments from domestic and foreign sources aggregated 65,667 short tons in 1908. The zinc content of these pigments, excluding those not made from ore, was 48,004 short tons.

A census of the capacity of the oxide plants of the United States shows that, running on ores of the same character as in the last two or three years, their maximum annual capacity is very nearly 110,000 short tons of pigment.

The following is a list of the plants which produce zinc oxide or zinc-lead oxide in the United States:

List of zinc and zinc-lead oxide plants in the United States.

Mineral Point Zinc Company	Mineral Point, Wis.
New Jersey Zinc Company	Newark, N. J.
New Jersey Zinc Company (of Pennsylvania)	Freemansburg, Pa.
New Jersey Zinc Company (of Pennsylvania)	Palmerton, Pa.
New Jersey Zinc Company (of Pennsylvania)	South Bethlehem, Pa.
Ozark Smelting and Mining Company	Coffeyville, Kans.
Ozark Smelting and Mining Company	Joplin, Mo.
United States Smelting Company	Canon City, Colo.

The large plant of the Tri-Bullion Smelting and Development Company, in course of erection at Canon City, Colo., was not completed, on account of the financial depression, and is not now expected to be in operation before 1910.

The oxide plant of the Empire Zinc Company, situated at West Plains, Mo., has not been in operation for some years.

SECONDARY ZINC.

In the ordinary method of galvanizing, where the material to be coated is dipped into a bath of molten zinc, there is great loss of zinc in the form of semioxidized skimmings and of hard zinc drosses, caused by the alloy formed by the zinc with the iron of the tank and of the article to be galvanized. In the larger galvanizing plants there are furnaces to refine these skimmings and drosses and to recover the spelter. There are also many small plants and some large ones which make a practice of buying up galvanizer's skimmings and drosses and of recovering the spelter. Once in a while the zinc smelters running on ore find occasion to work in a quantity of secondary material. In such cases they have made the proper returns to the Geological Survey, and account has been heretofore taken of such production in these reports as dross spelter. A considerable quantity of old metal in the form of various alloys of zinc and copper and other metals is also worked over and brought up to the desired composition by the addition of new metal. In the preparation of this report the attempt was made to get returns of production from as many of these refineries as possible. At almost every brass foundry in the country it is the custom to remelt and use filings, grindings, and scrap copper and brass, and it is manifestly impracticable to attempt to take full account of such. The table given below embodies the output of 40 of the largest refineries of secondary zinc. On a later page the production of secondary spelter in Europe is given.

Production of secondary zinc in 1907–8, in short tons.

	1907.	1908.
Secondary spelter	18,841	16,970
Recovered zinc in alloys	1,417	665
Total secondary zinc	20,258	17,635

Inasmuch as this secondary spelter takes the place of so much primary spelter, it is to be added to the figures of consumption of zinc in arriving at the actual consumption.

The recovery of secondary zinc is rapidly increasing, as is shown by the falling off in exports of zinc dross from 15,887 short tons in 1906 to 9,593 short tons in 1907, and to 8,405 tons in 1908, and this in spite of a large increase in the use of zinc for galvanizing. Besides increased recovery of secondary zinc as secondary spelter and in alloys, there is an increase in the use of zinc skimmings and drosses in the manufacture of lithopone, and of zinc chloride used in wood preservation. Exact figures are not available for the use of secondary zinc in pigments, but the quantity is estimated to be about 500 tons. The United States Department of Agriculture estimates the quantity of zinc chloride used in 1908 for wood preservation as 19,000,000 pounds, containing 4,500 short tons of metallic zinc derived from secondary sources, such as galvanizer's skimmings and drosses.

COMPARISON OF STATE TOTALS, BASED ON SMELTER AND ON MINE REPORTS.

The foregoing figures of the production of spelter by the respective States are compiled from reports from individual zinc smelters. For several years the production of the more valuable metals in the Western States has been also obtained by the Geological Survey from reports of individual mines, and since 1907 this has been extended over the whole country. In order to put the smelter production on the same basis as the mine figures, all the zinc which is manufactured into pigment directly from ore (excluding the quantity in zinc oxide manufactured from spelter, the inclusion of which would entail its duplication in the totals) is added to the production of metallic zinc. The zinc recovered from secondary sources is excluded, since it has already been once reckoned as spelter. These facts must be borne in mind in comparing this table with the table showing the production of spelter. The state totals obtained by each method are compared in the following table:

Comparison of state totals of the production of zinc, 1907–8, based on smelter and mine reports, in short tons.

State.	1907.				1908.			
	Totals based on smelter reports.	Totals estimated from mine reports.	Differences.		Totals based on smelter reports.	Totals estimated from mine reports.	Differences.	
			Smelter excess.	Mine excess.			Smelter excess.	Mine excess.
Arizona	89	114	.....	25	152	339	.....	187
Arkansas	1,911	474	1,437	.....	2,002	605	1,397	.....
California	140	116	24	.....	27	0	27	.....
Colorado	33,644	26,394	7,250	.....	29,907	15,065	14,842	.....
Idaho	3,508	3,493	15	.....	581	19	562	.....
Illinois	1,468	737	731	.....	298	1,717	.....	1,419
Iowa	220	145	75	.....	516	395	121	.....
Kansas	13,850	17,772	.....	3,922	8,628	14,119	.....	5,491
Kentucky	385	0	385	.....	341	0	341	.....
Maine	1	0	1	.....	0	0	.....	.....
Missouri	142,024	116,752	25,272	.....	123,655	107,404	16,251	.....
Montana	0	122	.....	122	900	820	80	.....
Nevada	1,692	1,084	608	.....	398	558	.....	160
New Jersey	59,588	69,369	.....	9,781	47,643	67,165	.....	19,522
New Mexico	1,038	375	663	.....	616	1,788	.....	1,172
Oklahoma	719	1,657	.....	938	2,235	4,529	.....	2,294
Tennessee	181	109	72	.....	341	344	.....	3
Texas	16	22	.....	6	0	18	.....	18
Utah	2,447	2,726	.....	279	282	730	.....	448
Virginia	771	0	771	.....	910	705	205	.....
Wisconsin	16,984	18,490	.....	1,506	18,598	18,206	392	.....
	280,676	259,951	.....	.....	238,030	234,526	.....	.....

The smelter state totals represent actual recovery and are found by summing up the total production reported by all companies for each State, respectively, all pigments being recalculated back to equivalent metallic zinc on the basis of average analysis of product. In compiling the mine totals each producing property is requested to report actual tonnage of zinc ores and concentrates shipped, and from this the zinc content is reckoned by assay value. From that zinc content 15 to 25 per cent, according to the character of the ore, is deducted for smelting losses, and the remainders thus obtained from all the producing properties in each State are combined to afford the total for the respective States. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content and the theoretical recovery be correctly estimated. Theoretically, the state totals, as compiled from smelter reports and from mine reports, respectively, should in the long run agree fairly closely. As a matter of fact, for any year, they show considerable divergence. These discrepancies, giving rise to "smelter excess" or "mine excess," may be the result of one cause or of a combination of causes, among which are: Lag in the smelting of the ore resulting in accumulation of ore stocks at the smelters; lag in the mining, owing to which the smelter depletes its ore stocks; error in calculating metallic contents from assay and in estimating recovery, and error in exact distribution of ore, by States, according to source. These various causes have been considered somewhat more fully in the lead report.

DISCUSSION OF MINE AND SMELTER STATE TOTALS.

In Arkansas the smelter excess is due to erroneous apportionment by a smelter. In Colorado the smelter excess in part accounts for the large mine excess in 1906, and is possibly in part due to too great allowance for smelting losses. In Idaho the smelter excess is due to lag. The mine excess in Illinois is in part due to lag and possibly in part to error in apportionment, the spelter being credited to Wisconsin by the smelters. The smelter excess in Iowa is due to erroneous apportionment. The mine excess in Kansas, as well as that in Oklahoma, are due to error in apportionment, the spelter being credited to Missouri. The smelter excess in Kentucky is due to erroneous apportionment. The smelter excess in Missouri is due in part, as explained above, to error in apportionment, and also in part apparently to too great allowance for smelting losses. The mine excess in New Jersey is accounted for in part by lag in smelting and in part by the exports of zinc ore, which, as shown on another page, were all from that State. The mine excess in New Mexico and in Utah is due to lag, as is also the smelter excess in Virginia.

REDUCTION.

CONCENTRATION AND SEPARATION.

FLOTATION METHODS.

The main feature of development in ore dressing during 1908 was the successful employment of flotation methods in practical use. Several of these methods had demonstrated their efficiency in experimental tests and a few in actual practice, but it was not until

the latter part of 1907 that they were accounted completely successful and only in 1908 that they were widely employed. They have received their chief application in Australia and Europe, but have had several experimental tests and a few practical trials in the United States.

Although the physics of ore flotation is as yet somewhat obscure, it is generally conceded that the principles concerned deal with the mechanics of the free surface of a liquid in contact with solids, and include adhesion, surface tension, and superficial viscosity, the latter more particularly in the case of the McQuisten process, to be described later. The liquid in question is water, and the free surface exists at the periphery of the bubbles of air or of carbonic acid gas, as well as at the upper surface of the liquid. In both cases the surface film of water resists rupture by different minerals with different degrees of strength, varying inversely with the adhesion of water to these different minerals. The greater the adhesion of water to the mineral the more easily it is wetted; the less the adhesion of water to the mineral the more it resists wetting. This property of resistance to wetting is the primary factor in ore flotation. Thus, the surface film of water resists rupture by the sulphides (or the sulphides resist wetting) most strongly, by the ordinary gangue minerals less strongly, and by quartz scarcely at all. It is found that these differences are emphasized if the material to be treated is mixed with oil, the adhesion of which to sulphides and gangue material is the reverse of that shown by water. Moreover, oil being lighter than water, is itself an active agent of flotation. Oil also assists in flotation by serving to agglomerate the sulphide particles.

If carbonic acid gas be generated from the gangue minerals by the addition of sulphuric acid to the tank in which the ore is being treated, the small rising bubbles selectively attach themselves to the particles of metallic sulphide introduced at the bottom of the tank and float them to the surface, where they are drawn off as an oily metallic scum, the gangue settling to the bottom. The selective attachment of the gas bubbles, upon which the success of the flotation and concentration depends, is a measure of the degree of adherence of the gas bubble to the different sulphides and gangue minerals; and that in turn is an inverse measure of the adhesion of water for the same particles. The particle of sulphide for which water has least adhesion—that is, which resists wetting most strongly or with which water has the largest angle of capillarity—will on coming in contact with the gas bubble be forced farther into the bubble, with resulting greater adherence to it.

Among the means used to accelerate the process and effect a more perfect separation are deepening the tanks, heating the liquid, and partially exhausting the air above the liquid in the tank.

The forces employed in ore flotation are most delicately balanced. Consequently in any given case the process to be worked will require adjustment to the character of the ore by careful experimentation. This undoubtedly accounts for the local failure of flotation processes elsewhere successful. The zincy tailings so well treated in Australia seem especially adapted to flotation. Experiments indicate that this success is largely due to the proportion of gangue to sulphide and to the presence of manganese and iron carbonates in the gangue. Experimentally the clean zinc concentrates refused to float. Upon

the addition of the requisite amount of inert gangue the flotation was successful. But on the addition of an excess of inert gangue all sulphides, including the zinc sulphide, sank. As to the presence of an air film enveloping the sulphide particle and the part this film plays in the flotation there is difference of opinion. The papers of Messrs. Swinburne and Rudorf[a] and of Professor Huntington,[b] while rather sharply opposed as to interpretation of the general facts of ore flotation, offer about the only available experimental data. These papers and their discussion comprise a general exposition of the subject from several points of view. As has been shown in the foregoing notes, the field of flotation concentration is limited to the separation of the minerals which resist wetting (generally the metallic sulphides) from the easily wetted minerals and gangue. Where two or more minerals are floated, a further separation must be made, magnetic or table, as the case may necessitate.

FLOTATION IN AUSTRALIA.

In the Broken Hill district of Australia there are large accumulations of zinciferous tailings, the result of years of exploitation of the zinciferous silver-lead ores. By various authorities these heaps of tailings are estimated to amount to about 6,000,000 or 7,000,000 long tons, and to contain about 1,200,000 long tons of zinc, 350,000 long tons of lead, and 40,000,000 ounces of silver. Several of the companies mining these ores have developed flotation processes, more or less similar and all employing the buoyancy of air or carbonic acid gas bubbles. The oxidized and weathered tailings are somewhat harder to handle than the fresh tailings, but the addition of sulphuric acid to the solution cleans off the oxidized film and renders the sulphide particles subject to the forces of flotation.

The importance of Australian competition in the production of zinc ore justifies a brief description of the principal flotation methods in use in that country. According to a table published in the London Mining Journal, the recovery of zinc concentrates from zincy tailings, both new and old, in the Broken Hill district in 1908 was as follows:

Production of zinc concentrates at Broken Hill, New South Wales, in 1908, by companies and processes.

Company.	Process.	Tailings.	Concentrates.
		Long tons.	*Long tons.*
Sulphide Corporation	Ballot	182,340	98,000
Broken Hill Proprietary	Potter	276,703	64,373
Zinc Corporation	Elmore	131,965	45,707
Minerals Separation Co	Ballot		32,197
De Bavay's Treatment Co	De Bavay	74,187	22,590

The Broken Hill Proprietary Company (Limited), with a dump pile of 3,000,000 tons of tailings, first used the Delprat process, employing a dilute solution of salt and sulphuric acid as the agent of

[a] Swinburne, J., and Rudorf, G., The physics of ore flotation: Trans. Faraday Soc., vol. 1, pt. 4, pp. 336–344.

[b] Huntington, A. H., The concentration of metalliferous sulphides by flotation: Trans. Faraday Soc., vol. 1, pt. 4., pp. 346–355.

flotation. Litigation between this process and the Potter dilute sulphuric acid process, resulted in a compromise by which the Proprietary Company obtained the right to use the Potter process, and the owners of the Potter process were granted the use of the Delprat patents elsewhere in Australia. The plant operated by the Proprietary Company, now using the Potter process, has an annual capacity of over 50,000 tons of 42 per cent zinc concentrates.

The Sulphide Corporation (Limited), operating the Central mine, has a tailings stack of over 1,000,000 tons. The tailings are worked by the Minerals Separation Company operating the Sulman-Picard-Ballot process, in which the tailings are mixed with a small quantity of oil or oleic acid and some mineral acid and then violently agitated with the water in the flotation tank, the sulphide concentrates rising in a froth. Two plants are in operation, one upon the weathered tailings, the other upon the current product of the mine. The total daily capacity is about 1,200 tons of tailings.

The zincy tailings from the Broken Hill North mine are handled by the De Bavay process. In this process the tailings, in the form of a thin paste, are gasified with carbonic acid gas and fed upon inclined tables which discharge into a trough where the sulphides float off and are carried to the bin for concentrates. The carbonic acid gas used may be ordinary flue gas. This process is slower, more complicated, more delicate, and apparently more expensive than the other processes, but is claimed to effect an almost perfect saving of the zinc. The De Bavay's Treatment Company has also acquired 370,000 tons of tailings from the Broken Hill Proprietary Block 10 Company and the current tailings output of the Broken Hill South Silver Mining Company.

The Zinc Corporation (Limited) was formed to acquire the stocks of old zinc tailings. Among the tailings purchased were those of the Broken Hill Proprietary Block 10 Company, Broken Hill South Silver Mining Company, British Broken Hill Proprietary Company, and Broken Hill Proprietary Block 14 Company, amounting in all to over 2,000,000 long tons. These, with the current output of various mines already contracted for, are estimated to be sufficient to supply the present plant eleven years. The method used is the Elmore vacuum process, employing oil and dilute sulphuric acid, the flotation being assisted by a partial vacuum. The plant has a capacity of 800 tons of tailings per twenty-four hours. The tailings assay 20 per cent zinc, 5.75 per cent lead, and 8 ounces of silver to the long ton. The concentrates from the vacuum separation are treated on 20 Wilfley tables, which make 2 products, assaying as follows: (a) Zinc, 46.5 per cent; lead, 7.25 per cent; and silver, 16 ounces to the long ton; (b) lead, 58 per cent; zinc, 15 per cent; and silver, 39 ounces to the long ton.

FLOTATION IN EUROPE.

The Elmore vacuum process has been installed in a considerable number of European mines, chiefly to separate copper sulphides from various gangue minerals, but in some instances to recover zinc blende.

FLOTATION IN THE UNITED STATES.

Several systems of flotation have been developed in the United States and the Elmore and McQuisten processes have been tried at a number of places in the United States, as shown below.

The "Criley and Everson oil process" was tried at Baker City, Oreg., in 1890, to separate sulphide ores from their gangue.[a] The crushed ore was mixed with black, thick oil and added to water slightly acidulated with sulphuric acid and heated to near the boiling point. The sulphides rose to the surface in a thick scum, leaving clean quartz gangue behind. No details of further commercial utilization of the method are available.

The Sanders flotation process was first tried in western Kentucky to make the difficult separation of zinc blende from fluorspar. The crude ore, containing lead, zinc, and fluorspar, is crushed and screened through a 20-mesh screen, after which it is passed to concentrating tables of the Wilfley type, which make three products—lead concentrates, zinc-fluorspar middlings, and fluorspar tailings. The middlings go to the flotation tanks, where they are gently agitated in a bath of neutral or basic aluminum sulphate (alum) at a temperature of 85° to 90° C. Small bubbles of gas, said to be H_2S, buoy the sulphides to the surface and float them off into the settling tank. The recovery of the zinc contents of the middlings is claimed to be from 80 to 90 per cent, and the cost of the flotation treatment is put at 34 cents per ton—both estimates as determined in a test upon western Kentucky fluorspar-lead-zinc ore at the plant in Marion, Ky. An equipment consisting of 2 flotation tanks, each of 100 tons capacity, employing the Sanders process, was installed in 1908 in the concentrating plant of the Tri-Bullion Smelting and Development Company at Kelly, N. Mex., to separate blende and pyrites.

The original McQuisten process is a water flotation method pure and simple, but a later patent provides for the preliminary treatment of the tailings with oil. No acid or gas enters into the flotation. The machinery consists of a tube, 1 foot in diameter and 4 to 6 feet in length, which is slowly revolved with the horizontal axis slightly lower at the discharge end. The finely ground pulp is fed in at the upper end of the tube, the inside of which shows a closely coiled spiral groove. As the thin pulp discharges into the tube some of the sulphide particles are caught and held on the surface of the water by the surface tension and superficial viscosity of the water. The more easily wetted gangue minerals and the sulphides which do not float sink to the bottom of the tube; caught in the spiral grooves, the sunken material by the revolution of the tube is lifted above the surface of the water again, when another portion of the sulphides is floated. By the repetition of this action the surface of the water near the discharge end of the tube becomes covered with a dusty coat of the sulphide, which floats off into the discharge tank and is conveyed to the concentrate bins. The tailings from the tube are sent to other tubes, until there is no longer any flotation of sulphides. In a compact form of installation the tubes are arranged in series of two or three each, one above the other. For the successful operation of the process, the pulp must be deslimed before treatment, as otherwise the very fine slowly settling particles of gangue

[a] Eng. and Min. Jour., vol. 50, Nov. 15, 1890, p. 581.

may be floated off with the ore. A plant of 125 tons capacity, employ ng 100 tubes arranged in sets of four each, as installed at the Adelaide mine, Golconda, Nev., is described [a] as making a successful separation of chalcopyrite with minor quantities of other sulphides from a dense quartzose gangue with spinel and garnet. Experimental tests have also been made upon the copper ore from Ely, Nev., upon copper ore from the Newhouse mine in Utah, and upon the zinc ore at Rico, Colo., the results of which are not available.

The Elmore vacuum process has been tried experimentally upon various lead-zinc ores in the works of the Empire Zinc Company, at Canon City, Colo., and in the Lanyon mill, at Salt Lake City, Utah. So far, however, the tests have been successful on but few ores. Tests of zinc ores containing siderite from the Ruth and the Blue Bell mines of British Columbia [b], gave good results with simple acid flotation. Ores from similar mines which did not contain siderite gave poor results.

Experience has shown that the Australian flotation methods can not be applied bodily to the lead and zinc ores of this country, but that the delicate balance of the flotation forces must be adjusted to individual ores. Future experimentation will, no doubt, find here a profitable field for such methods.

ELECTROSTATIC SEPARATION.

The process of roasting and magnetic separation continues to be used for the separation of pyrite from blende on account of cheapness, simplicity, and effectiveness of separation; but electrostatic separation has made great advances for such purposes. The principle of electrostatic separation is that materials which are good conductors, passing over a surface highly charged with electricity (an electrode), will be rapidly charged with like electricity and will consequently be repelled. Poor conductors, on the contrary, will be slowly affected and will drop nearly perpendicularly from the field. A separation is thus made, which may be made sharper by passing the concentrated material over a surface charged with the opposite electricity, when the charge in the good conducting material is reversed and the material is rapidly repelled, while the poorly conducting material, being charged with opposite electricity, is drawn to that electrode surface. Among the good conductors are nearly all the metallic minerals, and among the poor conductors are zinc blende and zinc carbonate, and nearly all gangue minerals and country rocks. Thus the process is especially adapted to make the difficult blende-pyrite separation.

The Blake-Morscher separator was an early type of machine embodying this idea, and one which was successfully used except when atmospheric conditions interfered with the operation of the static electric machine. The Blake-Morscher patents have now passed to interests allied to the American Zinc, Lead and Smelting Company, which controls also, for the United States, the Huff electrostatic separator. The latter machine is now superseding the older machine, which in fact is no longer manufactured.

The plant at Platteville, Wis., of the American Zinc Ore Separating Company, affiliated with the American Zinc, Lead and Smelting

[a] Eng. and Min. Jour., vol. 84, 1907, pp. 765–770.
[b] Report of the British Columbia Zinc Commission, 1906, pp. 123–128.

Company, after several months' successful operation upon Wisconsin pyritiferous blende concentrates, has been enlarged to 100 tons daily capacity by discarding the Blake-Morscher machines and adding more Huff machines. Working upon material which assays 30 per cent zinc and 20 per cent iron, the zinc product assays 56 per cent zinc and 4 per cent iron, while the iron product assays 39 per cent iron and 5 per cent zinc.[a]

Huff separators are being installed in the concentrating plant of the United States Smelting, Refining and Mining Company at Bingham Junction, Utah, to treat the zinc blende-pyrite middlings.

The Sutton, Steele & Steele dielectric separator is an electrostatic separator in which the electric charge is somewhat differently applied. An electrode consisting of a row of sharp points and charged at high tension, preferably by an electrostatic generator, is opposed to a revolving metallic grounded electrode. The ore, fed upon the revolving electrode, comes into the field and is electrified, the particles with good conduction immediately losing their charge to the grounded electrode and dropping inertly, while the poor conductors stick to the revolving electrode and are brushed from it beyond the field. A division of the nonconductors depending upon their specific inductive capacity is also claimed, which allows, for instance, the separation of zinc blende from fluorspar and from barite. These dielectric separators are installed in the Grasselli Chemical Company's plant at Park City, Utah, which is treating the zinc middlings from the Daly-Judge mine.

HYDRAULIC CONCENTRATION.

Progress in jigging has been mainly toward reduction of space, increase of capacity, and decrease of water consumption. Among the designs which have succeeded in these particulars are the Woodbury classifier jigs and the Richards pulsator jigs and classifiers. The Woodbury, the Hodge, and the Hancock jigs have replaced all older forms of jigs in the Lake Superior copper region, and the last named has recently replaced the Hartz jigs in the large mill of the Federal Lead Company at Flat River, Mo., 9 of the Hancock jigs taking the place of 132 Hartz jigs, with consequent saving of power and water and increased efficiency. A Hancock jig was installed to treat the fine screened residues from the New Jersey Zinc Company's oxide plant at Hazard, Pa., to recover the three products, zinc ore, manganese clinker, and unburned coal. An immense pile of these residues has accumulated in the years of operation of the plant, 98 per cent of which consists of the three recovered products, the remaining 2 per cent of waste consisting of ash. The Foust jig continued to give satisfaction in the Joplin district and was installed in a number of new as well as in some old mills.

The usual number of new forms of concentrating tables of the Wilfley type appeared during the year.

PNEUMATIC SEPARATION.

The use of pneumatic concentrating machinery advances but slowly, owing chiefly to the quantities of dust attendant upon the process. The Sutton, Steele & Steele dry tables are installed in the

[a] Richards, Robert H., Ore Dressing, vol. 3, p. 1533.

Grasselli concentrating plant at Park City, where they are reported to be working successfully. They are being tried at the Lexington mine of the La France Copper Company at Butte, Mont., but on account of the complexity of the ore and of the losses in the dust they have not, according to report, as yet proved successful.

SMELTING.

RETORT ZINC SMELTING.

INCREASE IN SMELTING CAPACITY.

A considerable improvement in the recovery of zinc in retort smelting has been made in recent years, enforced in part perhaps by the small margin of profit prevailing since the latter part of 1907. The loss in smelting Joplin blende under the best conditions is probably not much over 10 per cent, and the average smelting loss upon Mississippi Valley ores must be well under 15 per cent. The loss in smelting zinc ores from the Western States, which ores are of lower grade and often contaminated with iron, is considerably higher.

During 1908 there was a considerable increase in zinc smelting capacity in the United States. The smelter of the National Zinc Company at Bartlesville, Okla., though completed in 1907, was not put in operation until 1908. Hegeler Brothers' smelter at Danville, Ill., was completed and put in operation in September. The United Zinc and Chemical Company completed a smelter near Springfield, Ill. and began operations near the close of the year.

The increase of smelting capacity designed to treat Australian zinc ores is of interest to American zinc producers. The Broken Hill Proprietary Company (Limited) is constructing at Port Pirie, New South Wales, a zinc smelter of 10 furnaces, with 1,440 retorts and a capacity of 8,000 long tons of spelter per annum. The first experimental furnace is now in operation, and the plant is expected to be completed and in operation early in 1910. The Sulphide Corporation (Limited) has decided to discontinue its zinc smelter at Cockle Creek and to smelt its zinc ore at the new plant of the Central Zinc Company (Limited) at Seaton Carew, England. These works of modern design have a capacity of 35,000 long tons of ore and of about 12,000 long tons of spelter per year.

The following table gives the zinc-smelting capacity of the United States as determined by a recent canvass:

Zinc-smelting capacity of the United States, by companies.

Company.	Location.	No. of roasting furnaces.	No. of zinc furnaces.	No. of retorts.
American Zinc, Lead and Smelting Co	Caney, Kans	3	12	3,648
Do	Dearing Kans	3	12	3,840
Bartlesville Zinc Co	Bartlesville, Okla	3	12	3,456
Bertha Mineral Co	Pulaski, Va	.....	10	1,400
Chanute Zinc Co	Chanute, Kans	2	4	1,280
Cockerill Zinc Co	Altoona, Kans	3	6	3,840
Do	Bruce, Kans	4	4	896
Do	Gas City, Kans	2	4	2,520
Do	La Harpe, Kans	4	3	1,856
Do	Fitsburg, Kans	4	6	1,344
Do	Nevada, Mo	3	3	672
Do	Rich Hill, Mo	3	3	672
Collinsville Zinc Co	Collinsville, Ill	4	12	1,536
Edgar Zinc Company	Cherryvale, Kans	8	48	4,800
Do	St. Louis, Mo	5	18	2,016

Zinc-smelting capacity of the United States, by companies—Continued.

Company.	Location.	No. of roasting furnaces.	No. of zinc furnaces.	No. of retorts.
Granby Mining and Smelting Co.	Neodesha, Kans.	3	12	3,840
Grasselli Chemical Co.	Clarksburg, W. Va.	.....	10	5,760
Hegeler Bros.	Danville, Ill.	1A	2	1,800
Illinois Zinc Co.	Peru, Ill.	5A	7	4,640
Lanyon-Starr Smelting Co.	Bartlesville, Okla.	2	10	2,880
Lanyon Zinc Co., (No. 1)	Iola, Kans.	2	10	3,340
Lanyon Zinc Co., (No. 2)	do.	3	10	3,320
Lanyon Zinc Co., (No. 3)	La Harpe, Kans.	4	10	3,200
Matthiessen & Hegeler Zinc Co.	Lasalle, Ill.	3A	5	4,380
Mineral Point Zinc Co.	Depue, Ill.	2A	5	3,840
National Zinc Co.	Bartlesville, Okla.	2	8	2,432
New Jersey Zinc Co. (of Pa.)	South Bethlehem, Pa.	.....	18	1,620
Do.	Palmerton, Pa.	.....	12	2,548
Pittsburg Zinc Co.	Pittsburg, Kans.	6	8	910
Prime Western Smelter Co.	Iola, Kans.	4	10	3,240
Do.	Gas City, Kans.	8	18	5,340
Sandoval Zinc Co.	Sandoval, Ill.	2	8	996
United States Zinc Co.	Pueblo, Colo.	6	7	1,680
United Zinc and Chemical Co. (No. 1)	Iola, Kans.	1A	4	2,144
United Zinc and Chemical Co. (No. 2)	do.	.....	2	480
United Zinc and Chemical Co.	Springfield, Ill.	.....	2	1,280
Wenona Zinc Works	Wenona, Ill.	1	2	512
Total		106	337	93,958
Total maximum smelting capacity, short tons.		.....	.....	404,960
Total maximum sulphuric-acid capacity, short tons.		.....	.....	131,500

The total maximum annual smelting capacity of the plants listed above is 404,960 short tons. Several of the smaller plants have not been operated for the last three or four years, and are probably abandoned; but as they could be put into operating condition by a few repairs, it is thought best to include them in the list. Those plants which have an "A" opposite the number of roasting furnaces operate in addition sulphuric acid plants having a total maximum annual capacity of 131,500 short tons of sulphuric acid. The Grasselli Chemical Company also operates an acid plant in connection with its roasting furnaces at Cleveland, Ohio, the roasted zinc concentrates being shipped to the zinc smelter at Clarksburg, W. Va.

NEW FORMS OF ZINC FURNACE.

The losses and expense attendant upon the lack of continuity of operation in retort zinc smelting have stimulated metallurgists to design forms of furnace in which the smelting operation should be continuous.

The Wettengel rotatable furnace,[a] although not continuous, is designed to save much trouble in charging and cleaning the retorts. These are arranged in batteries in a revolving steel shell. They are turned upright beneath individual hoppers for charging, are revolved into a horizontal position for distillation, and lastly are turned downward for discharging the residues. After recharging they are turned to the horizontal, 180 degrees from the position of first distillation. By thus alternating the top and bottom of the retort its life is presumably doubled and the residues do not accumulate on one side. So far as known to the writer the furnace has had no test in actual use.

[a] Electrochem. and Metallurg. Ind., November, 1908, p. 457.

The Hughes revolving furnace[a] consists of a rotary retort held in place in a rotary shell or combustion chamber. A stack ore hopper feeds continuously through an air-tight joint into the upper end of the gently sloping retort, which discharges both zinc vapor and residues into a stationary cylindrical condenser at the lower end. Both the size and the temperature of the condenser are controllable. The waste heat of condensation is carried through the hopper, preheating the charge which arrives at the retort with a temperature of about 400° C. A Hughes retort 8 inches in diameter and 6 feet in length is calculated to treat about 25 tons of ore in twenty-four hours. Savings are claimed in handling the ore, in more efficient use of the heat and in initial cost of plant. The furnace has not yet received the test of practical operation, but one is now being installed at Butte, Mont.

SMELTING ZINC IN THE BLAST FURNACE

Many attempts have been made to smelt zinc in the blast furnace though, as shown by the work of Hempel,[b] the zinc vapors are so diluted with other gases that they can not be condensed as a liquid but must come down as zinc dust. Hempel found that this zinc dust could be compressed 90 per cent, under a pressure of 1,500 pounds to the square inch, and in this form was in convenient shape for distillation in ordinary retorts. He therefore proposed, for difficult ores carrying lead and zinc with precious metals, that they be smelted in a blast furnace, recovering the precious metals with the lead, the zinc in the form of zinc dust being compressed for distillation. The plan has not been tried except on a small scale.

The Lungwitz process proposes the reduction of zinc ores in the blast furnace under such pressure that the zinc will be reduced as a liquid instead of being vaporized, as at ordinary pressure. Experiments have been carried on intermittently since 1905 at Warren, N. H., in a furnace of commercial size especially designed to meet the requirements of the process and capable of maintaining a pressure up to 120 pounds to the square inch. A full description of the plant and of the theoretical considerations has been given,[c] but up to the present no account of results has been published. It is reported that the furnace at Warren has been abandoned and that experiments will be resumed at Philadelphia, from which it may be inferred that success has not yet been attained.

CHEMICAL AND ELECTRO-CHEMICAL REDUCTION OF ZINC ORE.

The recovery of zinc from ores and zincky by-products, in the wet way by chemical and electro-chemical methods, has been advocated many times. Judged from analogy of the corresponding processes in copper and lead reduction, only those wet processes which propose to deal with intermediate products of zinc reduction will succeed. Only such other processes as are cyclic or yield valuable by-products, or utilize the by-products of other operations, and in which the solutions can easily be kept clean, are at all likely to meet with success.

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[a] Mining World, July 10, 1909, p. 131.
[b] Berg. und Hüttenm. Ztg. (Leipzig), 1893, pp. 355-360; 365-370.
[c] Eng. and Min. Jour., vol. 80, 1906, pp. 795-797; vol. 81, 1906, pp. 71-73.

The former difficulty of spongy deposits is now obviated by rotating the anodes, or by keeping the electrolyte in circulation, and by taking other precautions.

In the Hoepfner process the sulphide ores are given a sulphate roast, the sulphate is leached and converted into chloride by salt, and is then electrolyzed. As a zinc-producing process this method was not a commercial success. Worked as one in a series of operations in their chemical works by Brunner, Mond & Co., in England, waste calcium chloride being used instead of salt, the process produces 99.9 per cent pure spelter, which commands a premium on account of its purity, and yields as by-products calcium carbonate in a form desired by paper makers, and chlorine gas.

In the Laszczynski process [a] the calamine or roasted sulphide ores are leached with dilute sulphuric acid; the resulting liquor is purified and electrolyzed and yields metallic zinc. The zinc-free acid liquor from the vats is used again to leach fresh ore, making the process cyclic. With electric current at a cost of $17.50 per horsepower year, it is estimated that electrolytic zinc can be made from the crude ore at a cost of $12.50 per ton of spelter.

The Ashcroft and Swinburne method was worked out for the Broken Hill ores. It consists in subjecting the ores to the action of chlorine gas with the formation of metallic chlorides. The other metals being separated the zinc chloride is electrolyzed, giving metallic zinc and recovering the chlorine for further use. The process was unsuccessful in Australia because spongy zinc could not be prevented. It is used in the Castner-Kellner works to produce zinc chloride.

In the Baker-Burwell process the sulphides are treated with chlorine, preferably in a tube mill, which helps complete chloridizing. The chlorides are dissolved in hot water, the other metals precipitated, and the zinc and chlorine recovered by electrolysis. A plant employing this process is in operation at Elkhorn, Mont., and, according to Prof. F. W. Traphagin, [b] is reported to be successful.

In view of the demand for zinc chloride for timber preservation and of the probability of great increase in its consumption, as pointed out later on in this chapter, it would seem that a chlorination plant located in the Kansas-Oklahoma gas field, convenient to the salt fields of Kansas and to the zinc deposits of the Joplin region, might profitably reduce zinc blende to zinc chloride to supply this market. It is unquestionably an economic loss to take zinc drosses already in the metallic form and reduce them to chloride, when the chloride is in several processes an intermediate stage in the reduction of zinc ore to the metallic form.

ELECTRO-THERMIC ZINC SMELTING.

Experiments with electric zinc furnaces are in progress at several places in the United States, Canada, and Europe. The chief difficulties are both metallurgical, to secure the complete condensation of the zinc vapor as metal instead of partly or even chiefly as zinc dust, and commercial, to secure the electric current at sufficiently low cost. The metallurgical difficulty, which is the same that has met endeavors to smelt zinc in the blast furnace, as pointed out above, will probably yield to experiment. The commercial difficulty seems to

[a] Stoeger, Walther, The electrolytic recovery of zinc: Mining Jour. (London), vol. 85, 1909, pp. 143, 170.
[b] Mines and Minerals, May, 1909, p. 451.

limit the field of application of electric smelting of zinc to regions of cheap hydro-electric power. Fleurville,[a] discussing the work of Côte and Pierron, points out that, with the electrical horsepower year at 45–50 francs and fuel at 12–13 francs per ton, the older methods of zinc extraction have no advantage over electro-thermic methods. Snyder [b] estimates that an electric zinc smelting plant of 25,000 tons annual capacity, after the Snyder design, can operate at a cost of $2.50 less per ton of ore than the ordinary zinc smelting plant of similar capacity under like traffic and fuel conditions. Figuring a better zinc recovery for the electric furnace, together with gains to the ore producer through saving the penalties for the presence of iron, lead, and lime in the concentrates (these being either unobjectionable or advantageous to electric smelting), the same authority puts the advantage at $10 per ton of ore in favor of the electric plant. Gin[c] estimates that 52 per cent zinc blende can be smelted for about $4 less per ton in a Gin electric furnace plant having an annual capacity of 12,000 tons of spelter than in an ordinary smelter of the same capacity. Additional profit is figured in the greater recovery of zinc, which is put at 95 per cent. The foregoing estimates being those of the inventors, or of persons interested in special forms of electric zinc furnaces, are necessarily ex parte and perhaps somewhat optimistic. However, Lescher[d] who made an experimental study of the electric zinc furnace, concludes that with electric current at $18 per horsepower year the electric furnace has the advantage of the ordinary retort furnace to the amount of $9.10 per ton of ore. Although this figure of the cost of electric current is probably a reasonable one under favorable hydrodynamic conditions, it is plain that electric current generated in steam plants at a cost varying from $30 to $75 per horsepower year can not be commercially employed.

ELECTRO-THERMIC ZINC FURNACES.

Electro-thermic furnaces have been used in smelting zinc in Scandinavia since 1902. Plants using the furnaces invented by Dr. C. P. G. de Laval are in operation at Trollhättan, Sweden, where 3,000 horsepower is used in reducing zinc ore and zinc dross; at Sarpsborg, Norway, where 4,000 horsepower is used in recovering zinc from zinc dross, and at Hallstahammar, where 1,800 horsepower is used in smelting ore.[e] These plants are operated by hydro-electric power, which is reported to be available at from $5 to $6 per horsepower year. At Trollhättan the first result of smelting is blue powder, which is resmelted either alone or with more ore. An experimental plant with a de Laval cyclone furnace successfully produced zinc oxide at Sala, Sweden, from zinc tailings, of which there are large accumulations at the old silver mines. In the cyclone furnace the charge falls through a whirling blast of air or gas.

The furnace of M. A. Salgues is in operation at Champagne, in France, producing zinc oxide. Attempts so far to produce spelter have resulted in zinc dust only.

The electric zinc furnace of Côte & Pierron treats either calamine and carbon, or zinc blende and metallic iron. In the latter case the

[a] Experiments relating to the electrometallurgy of zinc, by E. Fleurville; Houille Blanche, 7, pp. 273–281, December, 1908; Trans. Electrochem. and Metallurg. Ind., vol. 7, November, 1909, pp. 468–472.
[b] Snyder, F. T., Electric zinc smelting: Trans. Tristate Mining Association, September, 1907.
[c] Gin, Gustave, The electrometallurgy of zinc: Trans. Am. Electrochem. Soc., vol. 12, 1907, pp. 117–136.
[d] Lescher, C. E., The electrothermic reduction of zinc: Bull. Colorado School of Mines, vol. 4, No. 4, January, 1909, pp. 206–242.
[e] Report of the British Columbia Zinc Commission, p. 129.

presence of air or carbon monoxide is avoided and an almost perfect condensation is secured. The first trials of the method and the furnace were made at Lyon in 1906 with a furnace of 100 horsepower. These proved successful, and a company named the Société de Fonderies Électriques was formed to develop the furnace and process on a large scale. Works were established at Arudy in the Lower Pyrenees in May, 1907, where the process has since been in operation with hydro-electric power equal to 300 horsepower at the electrodes, at a cost of $13 per horsepower year. At present zinc oxide, testing 98.6 to 99 per cent pure, is made and finds a ready sale in competition with oxide made in the older way. The inventors hope shortly to place on the market metallic zinc smelted in their furnaces.

The Canada Zinc Company (Limited), established at Vancouver, British Columbia, a small experimental zinc furnace built after the plans of Frederick T. Snyder. The results of the experiments with this furnace led to the erection at Nelson, British Columbia, of a Snyder furnace of 15 tons capacity, costing $125,000, governmental aid to the extent of $20,000 being extended by the province of British Columbia. The electric current is furnished by a hydro-electric plant at Bonnington Falls, on the Kootenay River, at a cost of $30 per horsepower year. The smelter began operations late in 1908, but numerous mechanical difficulties have made operations somewhat intermittent. The ore so far treated has averaged about 40 per cent zinc, 10 per cent lead, and 12 ounces of silver to the ton, from which is produced spelter and lead bullion. A short description of the plant, with illustrations, was given in the Report of 1908 of the Minister of Mines of the Province of British Columbia (pp. 173–175). An account of operations at the smelter appeared in the Nelson Daily News of December 17, 1908. Aside from these articles, very little information is available as to practical results. E. E. Jacobs, editor of the British Columbia Mining Record, says:[a] "The works built at Nelson for the treatment of lead-zinc ores by the Snyder electric process were in successful operation during the closing weeks of the year. It is claimed that, metallurgically, the process is distinctly successful, but that mechanical difficulties occasionally occur, the overcoming of which will be a matter of time and experience in the practical working of the plant." The London Mining Journal of August 21, 1909 (p. 226), in a review of mining in British Columbia for 1908, speaks of "the failure so far of the electric smelting plant at Nelson to achieve practical success." It is likely, however, that this pessimistic view is due largely to the absence of information.

Gin has described[b] a circulating induction furnace for the reduction of zinc or lead-zinc ores. Estimates of the cost of spelter production by this process have already been given. No data of the commercial operation of this furnace are available.

Woolsey McA. Johnson has taken out numerous patents for an electric zinc furnace. A recent one[c] is for a shaft furnace with a lining perforated for the escape of zinc vapor, and surrounded by a collecting chamber which leads to the condenser.

Stansfield & Reynolds have designed a resistance furnace[d] for the recovery of zinc, lead, and silver from ores of the Broken Hill type.

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[a] Eng. and Min. Jour., vol. 87, 1909, p. 250.
[b] The electro-metallurgy of zinc: Trans. Am. Electrochem. Soc., vol. 12, 1907, pp. 117–136.
[c] U. S. Patent No. 920473.
[d] Stansfield, Alfred, The Electric Furnace, p. 164.

The chief advantage of the electric furnace in zinc metallurgy will naturally be in the reduction of the complex sulphide ores containing zinc, lead, silver, etc. The Snyder, Johnson, and Stansfield & Reynolds furnaces are especially designed to treat such ores.

RESOURCES.

Before the scope of the mines report in these annual volumes was extended to cover the Eastern and Central States, it was appropriate at this point to consider the development of the zinc-mining industry during the year and to take note of discoveries of new zinc resources, both in new territory and in new relations in known territory. Now, however, in the mines report under each zinc-producing State there will be found a more complete account of all that pertains to the resources of zinc than would be expedient here. It may be well, however, at this point to recall attention to the great resources of zinc in Australia, already mentioned, which the perfection of flotation processes has made available.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

The world's production of spelter in 1908 declined 17,010 tons, or 2.1 per cent, from the production of 1907. The United States showed the greatest falling off, failing to reach the production for 1907 by 39,436 tons, a decrease of 15.8 per cent. The other countries which had a decreased production are England and Poland. The largest increase was made by Belgium, with a total gain of 11,544 tons, or 6.7 per cent. The next largest increase was made by Germany, with 8,928 tons, or 3.9 per cent. The output of the United States was 26.4 per cent, a little over one-fourth, of the production of the world. The following totals, apportioned according to the country where smelted and not according to the source of the ore, are taken from the annual statistical publication for 1908 of the Metallgesellschaft, the Metallurgische Gesellschaft A.-G., and the Berg- und Metallbank Aktiengesellschaft, of Frankfurt-am-Main, Germany. The figures are there credited to Henry R. Merton & Co., though revised somewhat from the advance figures issued by that firm and used in the advance statement of the United States Geological Survey.

The world's production of spelter, 1904–1908, in short tons.

Country.	1904.	1905.	1906.	1907.	1908.
Australia	.....	.....	1,131	1,098	1,198
Austria and Italy	10,192	10,315	11,883	12,522	14,063
Belgium	154,314	160,496	168,067	170,307	181,851
France and Spain	54,107	55,524	59,293	61,438	61,512
Germany:					
Rhine district	72,083	74,127	75,729	77,459	80,670
Silesia	138,538	143,243	150,282	152,611	158,328
Great Britain	50,949	56,140	57,971	61,286	60,029
Holland	14,442	15,176	16,150	16,526	19,017
Poland	11,693	8,422	10,595	10,735	9,740
United States	186,704	203,849	224,770	249,860	210,424
Total	693,022	727,292	775,871	813,842	796,832
United States percentage of world's production	26.9	28.0	28.9	30.7	26.4

PRODUCTION OF SECONDARY SPELTER IN EUROPE.

The following table of the production of secondary spelter in Europe is calculated to short tons from a table published by Rudolf Wolff, Kreuger & Co., of London. It includes the output of the larger regular producers only. The production of the United States is included for comparison:

Production of secondary spelter in Europe and United States, 1905–1908, in short tons.

	1905.	1906.	1907.	1908.
Austria-Hungary	3,505	3,674	3,931	3,315
Belgium	4,044	4,473	3,620	4,295
France	14,304	14,898	15,130	20,309
Germany	9,689	11,040	11,316	13,273
Great Britain	7,913	7,644	7,168	8,714
Holland	2,268	2,800	2,957	2,923
Russia	1,680	.....	1,680	1,680
United States	.....	.....	18,841	16,970
Total	43,403	44,529	64,643	71,479

IMPORTS AND EXPORTS.

Zinc imported and entered for consumption in the United States, 1902–1908, in short tons.

Year.	Block or pigs.		Sheets.		Old.		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1902	448	$36,536	68	$8,339	157	$8,299	$32,708	$85,882
1903	202	19,161	129	8,537	163	11,772	10,376	49,846
1904	341	34,211	17	2,230	36	3,247	10,394	50,082
1905	428	46,295	14	1,953	86	5,110	8,253	61,611
1906	1,021	240,632	22	3,236	79	7,647	2,904	254,419
1907	1,709	220,474	52	7,158	122	8,582	8,516	244,730
1908	776	78,160	37	4,570	37	2,014	5,645	90,389

General imports of zinc ore, 1904–1908, in short tons.

Source.	Calamine (free).	All other (dutiable).	Total.
1904.			
Canada	.....	.....	.....
Mexico	.....	2,264	2,264
	.....	2,264	2,264
1905.			
Canada	913	3,150	4,063
Mexico	6,180	11,894	18,074
	7,093	15,044	22,137
1906.			
Canada	423	.....	423
Mexico	47,778	7,213	54,991
	48,201	7,213	55,414
1907.			
Canada	.....	1,112	1,112
Mexico	84,984	17,021	102,005
	84,984	18,133	103,117
1908.			
Canada	634	6,772	7,406
Mexico	22,900	23,451	46,351
	23,534	30,223	53,757
Total Canada	1,970	11,034	13,004
Total Mexico	161,842	61,843	223,685
Grand total	163,812	72,877	236,689

Exports of zinc ore and of manufactures of zinc of domestic production, 1902–1908, in short tons.

Year.	Zinc ore.		Plates, sheets, pigs, or bars.		Zinc dross.[a]		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1902	55,733	$1,449,104	3,237	$300,557			$114,197	$1,863,858
1903	39,411	987,006	1,521	163,379			71,354	1,221,733
1904	35,911	905,782	10,147	1,094,490			117,957	2,118,229
1905	30,946	848,451	5,516	682,254			159,995	1,690,700
1906	27,720	733,300	4,670	583,526	15,887	$1,103,706	204,269	2,624,801
1907	[b] 20,352	579,490	563	75,194	9,593	560,944	186,203	1,401,831
1908	[b] 26,108	877,745	2,640	250,254	8,405	467,403	88,485	1,683,887

[a] Not enumerated prior to 1906.
[b] The exports consisted wholly of high-grade willemite ore from New Jersey.

Imports of zinc oxide, 1901–1908, in short tons.

Year.	Dry.	In oil.	Year.	Dry.	In oil.
1901	1,800	64	1905	1,718	171
1902	1,636	82	1906	2,096	146
1903	1,744	83	1907	2,656	181
1904	1,293	112	1908	2,318	105

Exports of zinc oxide, 1902–1908, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1902	5,358	$433,722	1906	15,578	$1,149,297
1903	7,215	578,215	1907	13,257	1,069,924
1904	8,157	628,494	1908	12,008	845,070
1905	11,280	810,203			

Imports of old brass fit only for remanufacture, 1903–1908, in pounds.

[Average composition about one-third zinc and two-thirds copper.]

Year.	Quantity.	Value.
1903	1,216,683	$154,260
1904	2,659,054	310,311
1905	9,676,798	1,169,320
1906	12,938,205	1,891,126
1907	7,957,015	1,344.753
1908	2,714,155	355,335
Total	37,161,910	5,225,105

CUSTOMS DUTIES ON ZINC ORES.

The tariff act of 1897 contained the following paragraphs:

ART. 181. Lead-bearing ore of all kinds, 1½ cents per pound on the lead contained therein, etc.

ART. 183. Metallic mineral substances in a crude state and metals unwrought not specially provided for in this act, 20 per centum ad valorem, etc.

FREE LIST.

ART. 514. Calamine.

ART. 614. Minerals, crude or not advanced in value or condition, by refining or regrinding or by other processes of manufacture.

The contention of various interests regarding the interpretation of these articles has been set forth in preceding reports. The conclusion (T. D. 27891) of the Board of General Appraisers was—

that the carbonates and silicates of zinc are included within the meaning of the term "calamine" as used in paragraph 514, and that they are free of duty under said paragraph and also under paragraph 614, and that the sulphide of zinc is free under the paragraph last named as crude minerals, etc., subject, however, to the qualification that when lead is found in these ores duty shall be taken on the amount of lead contained therein as described in paragraph 181.

The Government's application for review of the decision of the Board of General Appraisers was brought in the United States circuit court, southern district of Texas, Laredo division, where, April 21, 1908, re United States *v.* Brewster (T. D. 29006), the decision of the board was sustained. The Government took an appeal to the United States circuit court of appeals, fifth circuit, which, January 18, 1909, decided (T. D. 29547) adversely to the Government, affirming the decision of the lower court and sustaining the various decisions of the Board of General Appraisers. Whereupon the Treasury Department issued instructions (T. D. 29563) in accordance with the decision of the court to the collectors of customs, and these instructions held until the going into force, August 6, of the new tariff.

The tariff act of 1909 has the following sections relating to zinc ore, zinc, and to compounds containing zinc:

PAR. 55. Zinc, oxide of, and white pigment containing zinc, but not containing lead, dry, one cent per pound; ground in oil, one and three-fourths cents per pound; sulfid of zinc white, or white sulphide of zinc, one and one-fourth cents per pound; chloride of zinc and sulphate of zinc, one cent per pound.

PAR. 193. Zinc-bearing ore of all kinds, including calamine, containing less than ten per centum of zinc, shall be admitted free of duty; containing ten per centum or more of zinc and less than twenty per centum, one-fourth of one cent per pound on the zinc contained therein; containing twenty per centum or more of zinc and less than twenty-five per centum, one-half of one cent per pound on the zinc contained therein; containing twenty-five per centum of zinc, or more, one cent per pound on the zinc contained therein: *Provided*, That on all importations of zinc-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample, and report the result to the proper customs officers, and the import entries shall be liquidated thereon, except in case of ores that shall be removed to a bonded warehouse to be refined for exportation as provided by law. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

PAR. 194. Zinc in blocks or pigs and zinc dust, one and three-eighths cent per pound; in sheets, one and five-eighths cents per pound; in sheets coated or plated with nickel or other metal, or solutions, one and three-fourths cents per pound; old and worn-out, fit only to be remanufactured, one cent per pound.

Section 24 of the tariff act of 1909 provides for the establishment of bonded smelting warehouses for smelting or refining in bond of ores and crude metals, but makes provision for the withdrawal from same of lead alone. Upon application of the United States Zinc Company the Treasury Department has made the following ruling (T. D. 30015):

TREASURY DEPARTMENT, *September 29, 1909.*

SIR: In a letter dated the 24th instant the Department confirmed its telegram of the same date approving the application of the United States Zinc Company to bond as a warehouse of class 7 its works at Pueblo, Colo., for the smelting and refining of imported ores.

As it appears from correspondence with this company that the works have been bonded for the smelting of zinc ores and the exportation of the refined metal, I have to advise you that there is no provision in the tariff act of August 5, 1909, for the remission of duty upon zinc withdrawn for exportation from a bonded smelter, as section 24 of this act provides only for the exportation of lead from bonded smelters. Section 29 of the tariff act of July 24, 1897, provides for the bonding of the works of manufacturers engaged in smelting or refining metals, or both smelting and refining, and for the cancellation of the bonds for the payment of the duty upon the exportation of 90 per cent of the metals smelted or refined.

In the opinion of the department there is nothing inconsistent in the provisions of the two acts in so far as they relate to metals other than lead, and it therefore construes section 29 of the act of July 24, 1897, as remaining in force to this extent, and you are therefore authorized to permit the zinc to be withdrawn from the United States Zinc Company's works, located at Pueblo, as provided therein—that is, the bond given for the exportation of the refined zinc should be canceled upon the exportation of 90 per cent of the zinc as shown by the assay to be in the imported ore and so charged against the bond.

Respectfully,

CHARLES D. NORTON,
Acting Secretary.

SURVEYOR OF CUSTOMS, *Denver, Colo.*

CONSUMPTION.

In the following tables, showing the consumption of spelter in the world and in the United States for the period 1898–1908, the figures of foreign consumption are computed from statistics published by the Metallgesellschaft, etc. In those statistics consumption is calculated on the basis of production plus excess of imports over exports or minus excess of exports over imports, and altogether disregards smelter stocks. For the sake of comparison, the consumption of the United States is calculated by both methods. Although in the long run the stocks carried over from one year are consumed in the next and thus are equalized, it can not be gainsaid that for the individual year to take stocks into account gives greater accuracy. To obtain perfectly accurate figures of consumption it would be necessary to consider the stocks in the hands of consumers and dealers and to take into account the secondary spelter consumed. In any event, to the consumption for 1908 as given below, 215,401 tons, there should be added the production of secondary zinc for the year, 17,635 short tons.

An interesting fact is that the 16,294 tons excess of consumption over production in 1908 very nearly equals the 16,972 tons excess of production over consumption in 1907, presumably reducing the world's spelter stocks to the normal.

World's consumption of spelter, exclusive of secondary zinc, 1898–1908, in short tons.

Year.	Stocks considered.	Stocks disregarded.			
	United States.	United States.	Foreign countries.	Total world's consumption.	United States percentage.
1898	108,199	106,185	422,070	528,255	20.10
1899	124,585	123,688	422,181	545,869	22.66
1900	99,399	102,414	420,858	523,272	19.57
1901	141,697	137,789	424,496	562,285	24.51
1902	152,682	154,138	465,391	619,529	24.88
1903	154,381	157,900	480,162	638,062	24.75
1904	180,911	176,894	520,506	697,400	25.36
1905	200,438	198,835	534,285	733,120	27.13
1906	220,781	221,142	556,882	778,024	28.42
1907	228,524	251,049	568,346	819,395	30.64
1908	215,401	208,657	597,725	806,382	25.88

World's consumption of spelter, by countries, in 1907 and 1908, in short tons.

[Stocks disregarded except in the United States.]

	1907.	1908.		1907.	1908.
Austria-Hungary	34,171	35,925	Russia	19,290	19,946
Belgium	60,627	74,936	Spain	5,180	5,290
France	76,720	85,956	Other countries	13,228	11,020
Germany	192,792	198,580	United States	228,524	215,401
Great Britain	154,653	152,627			
Holland	4,189	4,188		796,870	813,126
Italy	7,496	9,257			

Consumption of primary spelter in the United States, 1907 and 1908, in short tons.

	1907.	1908.
Supply:		
Stock, January 1—		
In bonded warehouses		2
At smelters	3,824	26,364
Production	249,860	210,424
Imports	1,778	881
Total available	255,462	237,671
Withdrawn:		
Exports, foreign	9	8
Exports, domestic	563	2,640
Stock, December 31—		
In bonded warehouses	2	9
At smelters	26,364	19,613
Total withdrawn	26,938	22,270
Apparent consumption	228,524	215,401

Statistics of the use of spelter are not collected by the Geological Survey. The following table is from figures published in the Engineering and Mining Journal, which, though confessedly not complete, will, nevertheless, give an idea of the relative importance of the different uses of spelter for the period included.

Consumption of spelter in the United States, 1906–1908, by uses.

Use.	Percentage of total consumption.			
	1905.	1906.	1907.	1908.
Galvanizing	50.00	55.00	62.7	62.2
Brass making	26.00	25.25	18.4	17.2
Sheet zinc	17.00	16.00	12.4	14.1
Lead desilverization	1.25	1.00	1.1	1.3
Other purposes	5.75	2.75	5.4	5.2
Total	100.00	100.00	100.0	100.0

SPECIAL USES.

GALVANIZING.

Brief descriptions of sherardizing and of cowperizing, two new methods of galvanizing which were introduced into the United States in 1907, were given in the chapter on zinc in Mineral Resources for 1907. As these processes, as well as the electrolytic method of gal-

vanizing, consume zinc in the form of zinc dust, their bearing on zinc metallurgy and the production of zinc dust in the electric furnace was there discussed.

The introduction of the sherardizing process made good progress. A circular, issued by the company controlling the method, announces that sherardizing plants have been installed to date by 20 firms.

A new process of galvanizing, resembling sherardizing, has been patented (United States patent No. 928398). The iron or steel to be galvanized is coated with a paste composed as follows:

	Parts.
Zinc flue dust	88
Lampblack	2
Clay	10

The ingredients are mixed with water and applied to the cleaned iron or steel surface. The whole is placed in a furnace and heated to a temperature, the inventors say, of from 600° to 1,000° F. This heating is continued from half an hour to four hours, when the article is removed from the furnace and allowed to cool in a place which is free from oxidizing influences. The paste is now dried, but is easily removed, when it will be found that the surface of the iron or steel is coated with zinc.

ZINC DUST.

Zinc dust is an impalpable powder which forms in the distillation of zinc when the zinc vapor is cooled too rapidly in the condensers or is diluted by too large a volume of other gas. As noted in the preceding pages, it may constitute a large proportion of the metallic zinc obtained in electro-thermic zinc smelting, but in ordinary retort smelting it usually amounts to between 3 and 10 per cent of the reduced zinc. The powder consists of metallic zinc, with about 10 per cent zinc oxide, which probably exists as a film surrounding the metallic particles. These particles can not be made to coalesce by heating unless under great pressure but must be again vaporized and condensed.

Zinc dust differs from metallic zinc in other physical properties, such as rapid oxidation, absorption of hydrogen, and generally greater chemical activity, resulting at times in spontaneous combustion or explosion. These properties are believed by Sang[a] to be due to conditions of stress resulting from rapid solidification, somewhat analogous to the condition in "Prince Rupert's drops."

These peculiar properties of zinc dust are the cause of many of its uses. Under the name of "indigo auxiliary" a paste of zinc dust is used to discharge locally the color in dyeing cotton goods, giving a white pattern on the background of dye. Zinc dust is used in fireworks and in making hydrogen for balloons. It is the basis of the various methods of dry galvanizing, and is also used to furnish the zinc solution in electro-zincing. One of the most important uses of zinc dust is as a substitute for zinc shavings in zinc precipitation in the cyanide treatment of gold and silver ores. For this purpose it is cheaper, quicker, more effective, and more convenient than zinc shavings.

In American zinc-smelting practice, the zinc dust has been charged back into the retorts, since, under the former tariff, if sold as dust, it

[a] Sang, Alfred, Old and new methods of galvanizing: Proc. Eng. Soc. Western Pennsylvania, vol. 23, 1907, pp. 546-571.

came into competition with foreign zinc dust admitted free of duty, whereas recovered as spelter it was protected by an import duty of 1½ cents per pound. Hence the small quantity of zinc dust heretofore used in this country has been imported from Belgium and Germany. The quantity thus imported from Europe has not been recorded separately by the Bureau of Statistics, being included with all other "articles in a crude state used in dyeing and tanning." The only statistics available are those of the exports of zinc dust to the United States from Germany as given by Paul Speier in the London Mining Journal. According to this source, there was imported from Germany 946 short tons of zinc dust in 1907, and 1,312 short tons in 1908. The tariff act of 1909, as shown on a preceding page, establishes an import duty upon zinc dust of 1⅜ cents per pound.

ZINC CHLORIDE AS A WOOD PRESERVATIVE.

The principal application of wood preservatives thus far has been in the treatment of railroad ties, piles, telephone and telegraph poles, fence posts, shingles, wood paving blocks, and mine timbers; but the treatment will no doubt be extended in the future to include board walks, porch floors, floors laid on cement, and probably the weather-boarding of frame buildings. The chief preservatives used are creosote, zinc chloride, crude petroleum, and combinations of these materials. The creosote treatment is the more effective, but costs from two to four times as much as treatment with zinc chloride. Moreover, the creosote exudes upon the surface of the timber and is unpleasant on exposed surfaces, such as floors, and unsatisfactory where the surface is to be painted. On the other hand, the zinc chloride in damp or wet places will be leached out of the timber. To obviate this fault, the timber, after being treated with zinc chloride, is sometimes given a further superficial treatment of creosote or crude oil. Most of the zinc chloride used so far has been in treating railroad ties. In Texas pine ties, with an average life of two to three years and costing 25 or 30 cents each, have been treated with zinc chloride at a cost of 10 or 11 cents each, resulting in an average life of eleven years. In 1907, of the new ties laid, 13 per cent were treated with preservatives; in 1908 the quantity treated was 21.8 per cent. About 9,500 tons of zinc chloride, equivalent to 4,500 tons of zinc, were used in treating timber in 1908. To treat all of the 109,064,495 new ties laid that year would have required about 90,000 tons of zinc chloride, equivalent to 43,000 tons of zinc. On account of the financial depression, the number of new ties laid in 1908 was much smaller than usual. On the other hand, the extended use of preservatives will in a few years considerably reduce the number of new ties to be laid and thus limit the market for preservatives. Mine timbers also offer a field for the use of wood preservatives. In an estimate of the new timber used in mines in 1905, the quantity used by 5,000 mines reporting (covering fully 90 per cent of the total consumption of timber in mines) was put at 200,000,000 cubic feet. To treat this with zinc chloride would require 50,000 tons of the chloride, equivalent to 24,000 tons of zinc. Timbering adds about 8 cents to the cost of producing every ton of coal. The doubling or quadrupling of the life of timbers means a great saving in expense. It is evident that timber preservation offers a market for a large quantity of zinc chloride.

These notes are from data kindly furnished by the Forest Service of the United States Department of Agriculture.

PRICES.

The year opened with spelter selling at 4.25 to 4.35 cents per pound, a slight recovery from the low figures prevailing near the close of 1907. By a rather sharp advance reflecting conditions in Europe a price of 4.85 cents per pound was attained in February, after which the market subsided gradually until July, when a minimum of 4.40 cents was reached. The last half of the year was marked by a fairly steady advance, closing with spelter at 5.125 to 5.15 cents. Spelter stocks at the smelters were reduced 6,751 tons during the year, and exports were increased nearly 500 per cent, while imports fell off 50 per cent.

The European market exhibited very much the same course as the domestic market. The rally in February reaching £22 (4.76 cents per pound), the maximum value for the year, is attributable to definite information of the successful formation of the European zinc convention. The minimum price, £18 (3.89 cents per pound), reached in July, was due to dull conditions and to discouraging rumors with regard to the zinc association.

Price of common western spelter in New York City, 1902–1908, by months.

[Cents per pound.]

Year.	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	4.30	4.25	4.25	4.00	4.35	4.20	4.45	4.40
1903	4.90	4.55	5.05	4.97	5.75	5.05	5.75	5.50
1904	5.10	4.90	5.10	4.95	5.20	5.05	5.27	5.20
1905	6.20	6.10	6.15	6.10	6.15	5.87	6.00	5.75
1906	6.70	6.00	6.15	6.05	6.35	6.10	6.15	6.05
1907	6.80	6.70	6.90	6.70	6.90	6.75	6.80	6.55
1908	4.60	4.25	4.85	4.55	4.80	4.60	4.70	4.60

Year.	May.		June.		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	4.65	4.40	4.85	4.80	5.35	5.05	5.50	5.35
1903	5.80	5.75	6.25	5.75	6.25	5.87	6.00	5.80
1904	5.22	4.95	4.95	4.75	4.90	4.87	5.07	4.90
1905	5.70	5.40	5.35	5.25	5.60	5.25	5.80	5.60
1906	6.10	5.90	6.20	6.00	6.05	5.97	6.05	6.02
1907	6.60	6.35	6.45	6.35	6.35	5.85	5.90	5.50
1908	4.675	4.55	4.675	4.45	4.70	4.40	4.775	4.65

Year.	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1902	5.50	5.30	5.50	5.40	5.35	5.10	5.00	4.50
1903	6.10	6.00	6.12	6.00	6.00	5.25	5.25	4.65
1904	5.15	5.07	5.37	5.15	5.80	5.37	6.12	5.80
1905	5.95	5.75	6.15	6.00	6.25	6.10	6.60	6.40
1906	6.35	6.05	6.30	6.15	6.45	6.25	6.65	6.45
1907	5.50	5.05	5.55	5.25	5.25	4.50	4.55	4.10
1908	4.825	4.70	4.875	4.75	5.05	4.875	5.15	5.10

THE ZINC CONVENTION.

Rumors of the formation of a syndicate to control the European production of spelter were rife during 1908, and very decidedly affected the price of that commodity as has been seen above. Early in 1909, these rumors materialized in the organization of the Zinc Convention. The purpose of the convention is to fix beforehand, within certain limits, the production of spelter by its members, and, if the market gives evidence that the consumption is not keeping pace with the production, further to curtail production. The convention comprises the Zinkhüttenverband m. b. H. and the Société Anonyme des Mines et Fonderies de la Vieille Montagne. The former association embraces 18 zinc smelting firms in Silesia, the Rhine district, Belgium, and Austria. One large firm, Georg von Giesche's Heirs, does not belong to the association, but it is understood will act in concert. The Société Anonyme includes 10 smelters, mainly situated in Belgium. English smelters are expected either to join the convention or to act in agreement. The competition of American smelters is not anticipated in the immediate future. The convention is to remain in force until the close of 1910, but may be terminated upon a month's notice if outside producers so enlarge their output as to raise the total European production as much as 2 per cent above the total fixed by the syndicate. If the average price of ordinary brands of spelter remains below £19 (4.11 cents per pound) for six consecutive months, a pro rata reduction of the fixed output is to be made. The syndicate has already exercised a steadying effect upon the European zinc market.

SUMMARY.

Summary of spelter statistics for 1907–8.

	1907.	1908.
	Short tons.	*Short tons.*
Production of spelter by United States	249,860	210,424
Consumption of spelter by United States (stocks considered)	228,524	215,401
Production of zinc by world	813,842	796,832
Consumption of zinc by world (stocks considered in United States)	796,870	813,126
Excess of world production over consumption	16,972	.....
Excess of world consumption over production	.....	16,294
United States percentage of world production	30.7	26.4
United States percentage of world consumption (stocks considered in United States)	28.7	26.5
Rank of United States among zinc-producing countries	First.	Second.
Rank of United States among zinc-consuming countries	First.	First.

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GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE UNITED STATES.

(MINE PRODUCTION.)

PREFATORY NOTE.

The following account of the production of gold, silver, copper, lead, and zinc by mines in the various States is a part of the annual report on the gold, silver, copper, lead, and zinc industries in the United States. The portion of this general report dealing with mine production has been divided, for the sake of convenience and for distribution in advance of the final volume, into three sections corresponding to broad geographic divisions of the country. As a part of a comprehensive report devoted to the whole country, each section has a certain system and uniformity of treatment imposed upon it which might not in all cases be necessitated by the local conditions of the particular region with which it deals. Accordingly, the general scope of treatment, the arrangement, the tables, and the units of measurement conform as far as possible with those of the sections devoted to other parts of the country as being best adapted to expression of the features of the mining industry of the entire United States. The short ton of 2,000 pounds is used throughout. The price per unit of the production (gold excepted, which is fixed by law) is based upon the average for the year 1908 of daily New York prices for the metals, as follows:

Gold	per fine ounce (troy)	$20.671834625323
Silver	do	.53
Copper	per pound	.132
Lead	do	.042
Zinc	do	.047

It is to be understood, of course, that the full market values are not received for the metals in ore and intermediate products sold to the custom plants.

The full report on the industries of gold, silver, copper, lead, and zinc embraces the following sections:

Gold and silver (General report).
Copper (Smelter production).
Lead (Smelter production).
Zinc (Smelter production).
Gold, Silver, Copper, Lead, and Zinc in the Western States (Mine production).
Silver, Copper, Lead, and Zinc in the Central States (Mine production).
Gold, Silver, Copper, Lead, and Zinc in the Eastern States (Mine production).

The first four sections give summary reviews of the respective industries for the United States as a whole, together with general statistics based on returns from mints, refineries, and smelters; the last three sections give reviews of the industries also for the sections of the country indicated, by States, counties, and mining districts, and the production of each metal as reported directly to the Survey from the mines.

Each of these sections is published as a separate pamphlet and may be secured by addressing a request to the Director of the United States Geological Survey, Washington, D. C.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE WESTERN STATES.

(MINE PRODUCTION.)

ALASKA.

By Alfred H. Brooks.[a]

INTRODUCTION.

Measured either in terms of production or in amount of dead work accomplished or planned, the mining industry of Alaska during 1908 not only did not progress as much as was expected but in some ways showed a distinct decline as compared with 1907. This retrogression might discourage the mine operator were it not due in part to the widespread business stagnation which followed the financial panic and in part to certain conditions which are not unchangeable.

Though the gold placer mines already on a productive basis were not materially affected by the business depression, many of those requiring capital for extensive plants made but little headway. A more serious matter to the placer miner was the drought which prevailed throughout the summer months in nearly all the important districts. The lack of water so curtailed the output of all the Yukon and Seward Peninsula districts that the value of the total output of placer gold from these sources was about $700,000 less than in 1907. This decrease of the placer-gold production for Alaska as a whole is, however, but temporary, for the maximum annual output of the auriferous gravels has not yet been reached. In spite of the business depression the production of the auriferous lode mines of the Territory in 1908 was 21 per cent greater than in 1907. On the other hand, the fall in the price of copper from an average of 20 cents per pound for 1907 to 13.2 cents per pound for 1908 led to a decrease in output of that metal of 26 per cent and in value of 50 per cent as compared with that of 1907. However, the fact that operators of a number of mines continued to ship ore in spite of its low market value indicates the permanency of the copper-mining industry of the Territory.

Among the conditions that are retarding the advancement of the mineral industry are the lack of restrictions in the public-land laws under which placer ground is acquired and held, and the delays in obtaining title to coal lands, which has discouraged railway construction.

[a] Valuable aid has been rendered in the preparation of this report by C. W. Wright who wrote the part pertaining to southeastern Alaska and prepared the tables on lode mine statistics, also by E. M. Aten who assisted in the collection of statistics from placer mines. The data on mining development here presented are all taken from Bulletin 379, which deals with the region in a more detailed way; see Brooks, Alfred H., and others, Mineral Resources of Alaska, 1908; Bull. U. S. Geol. Survey No. 379, 1909.

As in previous years the Fairbanks placer district made the largest production of gold, with that of the Seward Peninsula placers as second, and that of the lode mines of Juneau district as third. The Ketchikan district was the largest producer of copper in 1908, but there were several productive mines on Prince William Sound, besides which there was much prospecting in the Chitna district and less prospecting in other regions. On the whole the hard times of 1908 rather stimulated prospecting in both the gold and copper fields all through Alaska.

As in previous years attempt has been made to base the statistics of production so far as possible on the statements of individual producers—the only reliable source of information. Though Alaska miners are gradually recognizing the importance of this work, there are still many who neglect to reply to the request for information. This prejudice against giving data of production is rapidly disappearing, it is believed, and it is confidently expected that absolutely reliable statistical data will soon be available. In the meantime recourse is had to the various sources of information. In connection with this work the writer is under special obligations to the many United States commissioners in the Territory, to bank officials, to the agents of the customs service, and to prominent residents, for valuable information. All these data have been carefully sifted, and the accompanying figures are based upon them. The limit of error of the statement of the total gold production of the Territory is believed to be within 2½ or 3 per cent. In the crediting of the proper amounts to individual districts, however, the error may in some cases be as high as 10 or 15 per cent. A preliminary statement of the distribution of the gold output has already been published.[a]

The following table is an estimate of the total gold production of Alaska since the beginning of auriferous mining in 1880. For the early years the figures are probably very far from being correct, but they are based on the best information now available.

Production of gold, silver, and copper in Alaska, 1880–1908.

Year.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Pounds.*	
1880	968	$20,000			3,933	$826
1881	1,935	40,000				
1882	7,256	150,000				
1883	14,566	301,000				
1884	9,728	201,000	10,320	$11,146		
1885	14,513	300,000				
1886	21,575	446,000				
1887	32,653	675,000				
1888	41,119	850,000	2,320	2,181		
1889	43,538	900,000	8,000	7,490		
1890	36,862	762,000	7,500	6,071		
1891	43,538	900,000	8,000	7,920		
1892	52,245	1,080,000	8,000	7,000		
1893	50,213	1,038,000	8,400	6,570		
1894	61,927	1,282,000	22,261	14,257		
1895	112,642	2,328,500	67,200	44,222		
1896	138,401	2,861,000	145,300	99,087		
1897	118,011	2,439,500	116,400	70,741		
1898	121,760	2,517,000	92,400	54,575		
1899	270,997	5,602,000	140,100	84,276		
1900	395,030	8,166,000	73,300	45,494	250,000	40,000
1901	335,369	6,932,700	47,900	28,598		

[a] Bull. U. S. Geol. Survey No. 379, 1909, pp. 26–28.

Production of gold, silver, and copper in Alaska, 1880–1908—Continued.

Year.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Pounds.*	
1902	400,709	$8,283,400	92,000	$48,590	360,000	$41,400
1903	420,069	8,683,600	143,600	77,843	1,200,000	156,000
1904	443,115	9,160,000	198,700	114,934	2,043,586	275,676
1905	536,101	15,630,000	132,174	80,165	4,805,236	749,617
1906	1,066,030	22,036,794	203,500	136,345	5,871,811	1,133,260
1907	936,044	19,349,743	149,784	98,857	6,308,786	1,261,757
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267
	6,660,204	142,228,055	1,812,831	1,118,268	25,428,714	4,263,803

Gold and silver production for 1880–1904 based on estimates of Director of Mint; for 1905–1908 from figures of United States Geological Survey.

Gold and silver quantities in fine ounces. Silver values are average commercial values for year and not coinage value. Copper production 1880, from Tenth Census, vol. 15, p. 800, 1900–1904. Copper values are based on average for year.

PRODUCTION.

The production and value of gold, silver, and copper for 1907 and 1908 are shown in the following table:

Mine production of gold, silver, and copper in Alaska, 1907–8.

	1907.		1908.		Decrease.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	936,043.81	$19,349,743	933,290.07	$19,292,818	2,753.74	$56,925
Silver.....do....	149,784.00	98,857	135,672.00	[a] 71,906	14,112.00	26,951
Copper.....pounds..	6,308,786.00	1,261,757	4,585,362.00	[b] 605,267	1,723,424.00	656,490

[a] Silver is valued at 53 cents per fine ounce. [b] Copper is valued at 13.2 cents per pound.

The value of gold production of Alaska in 1908 is estimated at $19,292,818 and that of silver at $71,906, and the number of ounces of gold at 933,290.07 and of silver at 135,672. In 1907 the output of gold was valued at $19,349,743. Though the total gold production was about the same in the two years, there was in fact a large decrease in the placer production of 1908 as compared with that of 1907; but this was in a large measure compensated by the increase in the output of the auriferous lodes. The copper output of Alaska for 1908 was 4,585,362 pounds, valued at $605,267, a decrease from 1907 of 1,723,424 pounds. Though the output of metallic copper in 1908 was less than in 1907, there was much more systematic prospecting for copper ores.

Mine production of gold, silver, and copper in Alaska, 1908, by districts.

District.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Pounds.*	
Pacific coast belt, including southeastern Alaska and Prince William Sound	166,812.39	$3,448,318	65,760	$34,853	4,585,362	$605,267
Copper River and Cook Inlet	19,422.56	401,500	1,467	777	.....	.....
Yukon Basin	499,375.12	10,323,000	47,868	25,371	.....	.....
Seward Peninsula	247,680.00	5,120,000	20,577	10,905	.....	.....
	933,290.07	19,292,818	135,672	71,906	4,585,362	605,267

In the following table the gold production of 1907 and 1908 is shown by districts:

Value of gold production in Alaska in 1907 and 1908, by districts.

District.	1907	1908.	Increase (+) or decrease (−).
Pacific coast belt, including southeastern Alaska and Prince William Sound	$2,891,743	$3,448,318	+ $556,575
Copper River and Cook Inlet regions	275,000	401,500	+ 126,500
Yukon Basin	9,183,000	10,323,000	+1,140,000
Seward Peninsula	7,000,000	5,120,000	−1,880,000
	19,349,743	19,292,818	− 56,925

With regard to the source of the metals according to character of deposits, the gold placers are still by far the largest producers, more than three-quarters of the entire output being credited to this source. The siliceous ores are next in value of product, and the copper lode mines last. The value of the gold production from the auriferous lode mines was $2,764,885 in 1907 and $3,357,335 in 1908, an increase of $592,450, which is to be credited to the mining operations in the Juneau district.

In the following table the source of the precious metals is indicated:

Sources of gold, silver, and copper in Alaska, 1908, by kinds of ore.

	Tonnage.	Gold.		Silver.		Copper.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*	
Siliceous ores	1,477,436	162,411.08	$3,357,335	31,966	$16,942	.....	.....
Copper ores	51,509	2,296.99	47,483	33,602	17,809	4,585,362	$605,267
Placers	.....	768,582.00	15,888,000	70,104	37,155	.....	.....
	1,528,945	933,290.07	19,292,818	135,672	71,906	4,585,362	605,267

Twelve auriferous lode mines were productive in 1908 as compared with 13 in 1907. Operators of 8 copper mines made shipments of ore as compared with 13 in 1907.

The tonnage of all the lode mines in 1908 was 1,528,945 short tons, an increase of 220,379 tons over that of 1907. Of siliceous ores 1,477,436 tons were mined, of which 1,367,920 tons came from the Treadwell group at Juneau. The average gold and silver extraction from all siliceous ores was $2.28 per ton. For the 109,516 tons of siliceous ores other than those from the Treadwell group the gold and silver value recovered was $3.33 a ton. The content of silver in siliceous ores was less than 1 per cent of the value of the ore. A total of 51,509 tons of copper ores yielded an average value of $1.26 per ton in gold and silver, and 4.45 per cent of copper.

It is estimated that during the summer of 1908, 770 placer mines were on a productive basis, and there were probably 500 during the preceding winter. A careful compilation of all the data indicates that there were about 4,400 men engaged in productive placer mining during the summer of 1908 and about 2,000 more in prospecting and development work.

REVIEW BY DISTRICTS.

PACIFIC COAST BELT.

SOUTHEASTERN ALASKA.

The output of the gold mines in southeastern Alaska during 1908 showed an increase of nearly $500,000 above that of 1907, though compared with the production of 1906 it decreased about $50,000. On the other hand, the copper mines, including those of Prince William Sound, showed a decrease of 1,723,424 pounds from the output of 1907 and a decrease of 1,286,449 from that of 1906. The increase in the gold output was from the mines of the Juneau district. The decrease in the copper output was caused by the decline in the price of the metal, which led to the closing down of some of the principal copper producers in the Ketchikan district and a suspension of operations at other mines for a portion of the year.

Juneau district.—The mines in the Juneau district productive during 1908 were the Treadwell group, the Alaska-Juneau, the Perseverance, Eagle River, Jualin, and Crystal mines.

The Treadwell mine has been opened largely on the 1,450-foot level, which will be used as a base level for deeper exploration, and to which the Seven Hundred Foot and the Mexican shafts will be extended. Below this level the shafts will be inclined to follow the dip of the ore body. On the Seven Hundred Foot claim the 100-stamp mill was reconstructed and put in operation early in February. A new shaft house was built, the shaft was extended to the 1,450-foot level, and the 1,250-foot level was partly developed. At the Mexican mine the extension of the shaft was in progress, and development work was continued on the 1,100-foot level. At the Ready Bullion mine the 1,500-foot level was developed, and the 750-foot level was extended to explore the south ore body exposed on the surface. The stamp mills at these mines were in continuous operation throughout the year. The use of oil in place of coal for all purposes has reduced the fuel expense considerably, and the supply of water has been increased by building dams on Ready Bullion and Fish creeks. Work is being advanced to obtain power from Turner Lake, on the east side of Taku Inlet, a distance of 18 miles from Treadwell.

Considerable progress was made at the Perseverance mine this year, though operations were handicapped by a lack of sufficient power. Development work was carried on throughout the year, and the main ore body was opened at the tunnel level for a length of 1,500 feet, its width varying from 60 to 100 feet. The 100-stamp mill of the property was started June 1 and was operated continuously until the end of October.

At the Alaska-Juneau mine mining was renewed the last of June and continued until the middle of October, and during this period the 30-stamp mill on the property was in continuous operation. The ore milled was derived principally from the open pits, and the mine developments consisted in extending a raise from the upper-pit tunnel to connect with the upper pit. Operations at the Ebner mine were suspended throughout the year pending a sale of the property.

Placer mining was in progress in Silverbow basin for several weeks early in the summer, but a lack of equipment prevented extensive operations, and little was accomplished.

At the Eagle River mine developments were advanced throughout the year, and the quartz veins which are displaced by faults, causing much difficulty in their exploration, have been located farther to the east on the various tunnel levels. The 20-stamp mill, which was supplied with ore principally from the upper mine levels, has been in in continuous operation throughout the year Encouraging results are reported from the Yankee basin prospects and from other properties within the Juneau gold belt.

The Jualin mine, the only property in the Berners Bay area where mining was done during 1908, was worked under lease by a small crew during the winter and spring months. Early in the summer, however, these operations were suspended, and the property has since been idle.

The mines south of Juneau have been inactive during the year, except the Crystal mine, at Port Snettisham, where work was in progress from April until November. The 5-stamp mill was in operation for fifty days, and an average of 15 tons a day was treated during this time.

Ketchikan district.—Little interest was shown in gold mines and prospects in the Ketchikan district during the year, and, except for the gold contained in the copper ores, the production of this metal was very small. The important mines are developing copper deposits, but because of the adverse conditions in the metal market the copper production of this district was 3,005,399 pounds—a decrease of 1,753,415 pounds below that of 1907.

The Mount Andrew and Rush and Brown mines were idle throughout the year. Mining was resumed in August at the Mamie and Stevenstown mines, and a relatively large tonnage of ore derived from them was treated at the Hadley smelter. Explorations at these mines are to be advanced during the winter months, though the smelter at Hadley will suspend operations and probably no ore will be shipped. The largest production and most extensive developments during the year were those made at the Jumbo mine, near Sulzer. The operations on this property were confined to the sulphide deposits at the head of Jumbo basin. The Niblack mine was operated from April 15 to October 30, during which period a shaft was sunk to a depth of 350 feet and the developments were extended to a 300-foot level. At the It mine, on Kasaan Peninsula, mining operations were begun in the spring and some high-grade ore was developed. A tramway 1 mile long was built to tidewater, a shaft was erected, and ore shipments were begun in the first part of October.

Sitka mining district.—The principal mining interests in the Sitka district are in the vicinity of Klag Bay, on the west coast of Chichagof Island, at the De Groff mine. On this property two ore shoots within a quartz vein have been developed at three different levels by tunnels following the vein. The 4-stamp mill on the property was operated the greater part of the year, and a considerable gold production was reported.

COASTAL REGION FROM CROSS SOUND TO ALASKA PENINSULA.

The mining of beach placers at Yaktag and on Kodiak and Popof islands continues in a small way, with an output not exceeding $30,000 in value annually.

Two mines on Prince William Sound, the Bonanza and the Gladhaugh, were operated for most of the year, and operators of several

other properties made small shipments. There was also a large amount of prospecting, and some discoveries were made on Fidalgo Bay and on the east side of Cordova Bay. Of significance is the discovery[a] of a quartz vein carrying gold values on Jack Pot Bay on the western side of Prince William Sound.

The mineral production of the district is shown in the following table. The figures for the years previous to 1905 are only approximations, for it was not until that year that the Survey began the collection of statistics directly from the producers.

Mineral production on Prince William Sound, 1900–1908.

Year.	Gold.[a]		Silver.[a]		Copper.		Percentage of copper per ton of ore.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fineounces.		*Fineounces.*		*Pounds.*		
1900							
1901					250,000	$40,000	
1902					360,000	41,000	
1903					1,200,000	156,000	
1904					2,043,586	275,676	
1905					1,580,379	246,539	
1906	870.75	$18,000	14	$9	1,521,340	293,600	4.1
1907	1,156.00	23,899	7,900	5,214	1,489,972	309,394	4.4
1908	56.75	1,173	8,954	4,745	1,324,963	174,895	4.9
					9,769,240	1,537,104	4.4

[a] Statistics for gold and silver output are only available since 1905.

During 1908 considerable work was done on copper and gold bearing lodes in the eastern part of the Kenai Peninsula, notably near Seward and Port Dick. Similar occurrences are also reported from Kodiak Island, which appears to lie in the same belt. Some productive work was done at the Apollo Mine on Unga Island and other deposits of the vicinity were systematically prospected.

COPPER RIVER BASIN.

Placer mining was continued during 1908 in the Nizina and Chistochina districts with a total production of about $150,000 in value. Systematic developments of copper deposits were continued at the Bonanza mine and on properties located on McCarty, Nugget, and Elliott creeks and on the Kotsina River, as well as at various other places. The Copper River Railway Company completed its line to Abercrombie Rapids where connection is made with steamboats navigating the river above.

Some work was also done in the Nabesna-White River belt. Both gold and copper bearing lodes have been found in this region, but it is relatively little developed.

COOK INLET-SUSITNA REGION.

The region tributary to Cook Inlet and drained by the Susitna, includes the Sunrise, Willow Creek, Yentna, and Valdez placer districts, which in 1908 made a total production valued at about $250,000. There was little activity in the Sunrise district. In Willow Creek interest centered on the discovery of gold-bearing quartz

[a] Grant, U. S., Gold on Prince William Sound; Bull. U. S. Geol. Survey No. 379, p. 97.

veins, the ores from which were treated in a small way with a 3-stamp mill. There was considerable mining on Valdez Creek and in the Yentna district. Important for these districts was the establishment of steamboat service on the Susitna and the building of a trail from Turnagain Arm to Kenai Lake where connection is made with the Alaska Central Railway.

YUKON BASIN.

The increased output of gold from the Yukon basin must be credited to the Fairbanks district, as in all the other districts, except in the Koyukuk, the low water during the summer led to a decrease in production. Outside of the Fairbanks district the most significant features of the mining industry were the successful operation of dredges in the Fortymile district, the discovery of some new gold-bearing creeks in the Hot Spring region, the finding of auriferous gravels in the Beaver Creek basin, and the exploitation of some deep gravels carrying a high gold tenor in the Koyukuk district.

Fairbanks district.—The total production for the Fairbanks district for 1908 was valued at about $9,200,000. About 300 different mining plants were in operation during the summer of 1908, employing probably 1,500 men. About 75 miles of creek have been found more or less productive. At least 80 per cent of this pay streak extends 40 feet in depth.

During 1908 some promising auriferous lodes were found in this field. There appear to be mineralized zones in the schists which are permeated with small quartz stringers, some of which carry free gold. So far as developed these occurrences seem to lie in the granite contact zones. The most promising discoveries are reported to be those in the headwater region of Cleary and Goldstream creeks.

Fortymile district.—The gold output of the Fortymile district was probably about $160,000 in value, though reliable figures are not available. Two dredges were operated for a part of the season on Walker Fork, and a smaller dredge on Fortymile near the international boundary.

Circle precinct.—The estimated value of the gold output of the Circle precinct during 1908 was $175,000, nearly half of which was taken out during the winter. The construction of the wagon road from Circle to the Birch Creek diggings, now in progress, and the wireless station already installed will help the development of this field very much. Dry weather seriously impaired operations in this district. The hydraulic plant on Eagle was in operation only a part of the time. A 6-mile ditch was completed to bring water from Bonanza, a tributary of Porcupine Creek, to Mammoth Creek, where a hydraulic plant is being installed. Auriferous gravels were found on Loper and Bachelor creeks, both in the Beaver Creek basin, during 1908, and give promise of extending the productive areas.

Chena-Salcha-Tenderfoot regions.—The reported discovery of rich placers in the Chena basin in 1907 has not been verified by later prospecting, though the field is known to be auriferous. The placers of the Salcha and the Tenderfoot basins were operated in 1908, with a production of about $250,000.

Rampart-Hot Springs district.—Mining was almost entirely suspended in this district during July and August on account of the low-water conditions.

The most important developments were in the southern part of the field. Here considerable work was done on Thanksgiving and Pioneer creeks, and, during the previous winter, on Sullivan Creek. The total production is estimated at $200,000 in value.

Bonnifield and Kantishna regions.—There was but little work done in the isolated Bonnifield and Kantishna regions. Of significance is the finding of an auriferous quartz vein in the Bonnifield, of sufficient size and value to lead to the erection of a small stamp mill.

Chandlar-Koyukuk district.—There was nothing of importance in the Chandlar district except the reported discovery of an auriferous quartz vein on Big Creek. As a result of the finding of rich gravel on Nolan Creek in 1907 there was much activity in the Koyukuk district, but no important discoveries were reported. The total production of this entire field during 1908 was about $250,000 in value.

Lower Yukon and Kuskokwim regions.—The Innoko district continues to attract prospectors, and some encouraging prospects have been found. A little work was done on about 25 claims located on Gaines, Ophir, and Little creeks, but only 4 of these have made any considerable output. The total production for 1908 is estimated to have had a value of about $70,000. Placer gold has also been found on Ruby Creek and Gold Mount, both near the Yukon, and on the Tuluksuk, a tributary of the lower Kuskokwim. All of these discoveries appear to lie in the same general belt.

Norton Sound.—Bonanza Creek continues to be the scene of the only productive placer mining in the Norton Sound region.

SEWARD PENINSULA.

Gold mining on the Seward Peninsula was much less active during 1908 than in 1907. This condition is reflected in the difference between the gold output of $7,000,000 in 1907 and of only $5,100,000 in 1908. The cause of this decline was due in part to the very dry season which prevented sluicing throughout much of the summer, but also to the exhaustion of the placers of the third beach line. It will take several years of preparation for mining the gravels of lesser gold tenor which have been almost entirely neglected.

The only established lode-mining enterprise of the peninsula, the Hurrah mine, was not operated during the year, though there was considerable work done on some prospects, some of which made a small output.

Some new beach deposits were found at Nome during the winter of 1907–8, but little is known of their extent or richness. One dredge was operated on Solomon River throughout the open season, and a second one for about six weeks. A dredge was launched on Bourbon Creek, but was soon after wrecked. Some other dredges are under construction. A 1,500-foot tunnel has been completed near the mouth of Iron Creek as a part of a large project to handle the gravels of that stream. Besides the 2 dredges mentioned, there was much mining activity on Solomon River, including the operations of 2 small dipper dredges and 1 steam shovel. There was but little work done in the Council and Kugerok districts, but in the Fairhaven district there was much more activity.

Kobuk district.—The gold-bearing gravels of Shingnek and Dahl creeks continue to be worked in a small way. Some copper and silver-bearing lodes are said to occur in the same field.

ARIZONA.

By V. C. Heikes.

PRODUCTION.

The Arizona output in 1908 of gold, silver, copper, lead, and zinc was valued at $41,811,975. This aggregate results from the reports made by 310 mine operators, including 31 placers. Copper constitutes 90 per cent of the total value of the metals. Gold, silver, lead, and zinc follow in rank in order named. The decreases in quantity of metal were made in gold and lead only. Copper showed the notable increase in quantity of 30,978,644 pounds in 1908 over that produced in 1907, but it showed a heavy decrease in total value. In the quantity of gold produced in 1908 Yavapai County led; Cochise County was first in copper, silver, and lead; and in zinc Mohave and Cochise counties greatly increased the output of 1907. Prominent as a producer of gold was the United Verde mine in Yavapai County, followed by the King of Arizona mine in Yuma County, the first producing only copper ore and the second dry siliceous ore. A large part of the total silver was produced from the copper ore of the Copper Queen mines in Cochise County and the United Verde mine in Yavapai.

At milling plants treating principally gold and silver ores 224,270 tons of ore were treated, including 64,148 tons of old tailings, which yielded in bullion nearly half the gold and one-fourth of the silver produced in Arizona in 1908. Although there was an increase of 21,275 tons in the quantity of gold and silver ores treated, the totals show slightly less gold and more silver recovered. The ore treated at concentration mills in 1908 amounted to 1,454,767 tons in quantity, which was one-tenth greater than in 1907. The concentrates containing gold, silver, copper, lead, and zinc aggregated 252,605 tons, valued at $8,505,668, or a total average value of $33.67 per ton. Half of the ore mined in 1908 was treated at smelters. It aggregated 1,810,078 tons, valued at $30,643,160 for the gold, silver, copper, lead, and zinc, and it averaged $16.93 in value per ton. The metal contents of 143,675 tons of old slag, which were resmelted, are included in the crude-ore totals. Compared with the figures of 1907 the tonnage of ore smelted increased 38,808 tons in 1908.

The statement of production for 1907 and 1908, showing increase and decrease and valued at each year's average commercial prices, is as follows:

Mine production of gold, silver, and associated metals in Arizona in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	126,612.52	$2,617,313	117,646.89	$2,431,977	− 8,965.63	− $185,33
Silver.....do....	2,511,897	1,657,852	2,808,450	1,488,478	+ 296,553	− 169,37
Copper.....pounds..	254,879,489	50,975,898	285,858,133	37,733,273	+30,978,644	−13,242,62
Lead.....do....	4,660,684	247,016	3,008,583	126,360	− 1,652,101	− 120,65
Zinc.....do....	228,490	13,481	678,446	31,887	+ 449,956	+ 18,40
		55,511,560	.....	41,811,975	.....	−13,699,58

Arizona had 8 of its smelting plants in operation during 1908, distributed, by counties, as follows: Cochise, 2; Gila, 1; Graham, 3; Pima, 1; and Yavapai, 1. All of these smelters treated copper ores. Five of them did a custom business, besides treating ores from properties owned by the same interests. About half the ore mined in Arizona was directly smelted, about four-tenths was concentrated, and the remainder was treated at mills using either cyanide or amalgamation processes. Although there are 3 plants equipped for lead smelting in the Territory, none of them was in operation, and the lead-bearing ores were shipped to Needles, Selby, and El Paso.

ORE PRODUCTION IN 1908.

The quantity of ore sold or treated in Arizona in 1908 was 3,696,938 short tons, inlueding a relatively small quantity of old tailings and slag. Compared with 1907 the production increased 129,805 tons in quantity, and decreased in value per ton from $15.55 in 1907 to $11.30 in 1908. Production of siliceous ore increased from 357,005 tons in 1907 to 375,500 tons in 1908. The greatest quantity of this kind of ore was produced in Cochise County. Copper ore increased from 3,191,125 tons in 1907 to 3,315,140 tons in 1908. Graham County had the greatest output of copper ore, Cochise County following. The production of lead ore decreased from 17,364 tons in 1907 to 5,519 tons in 1908 and zinc ore increased from 31 tons in 1907 to 695 tons in 1908. The average yield per ton of gold and silver in siliceous ore in 1908 was $5.32 as against $6.47 in 1907; in copper ore, 54 cents as against 56 cents in 1907; in lead ore, $15.64 as against $6.73 in 1907; and in copper-lead ore, $23.50 as against $15.20 in 1907.

The total tonnage, by kinds of ore, sold or treated in each county of Arizona during 1908 is shown in the following table:

Subdivision of tonnage of ore sold or treated in Arizona in 1908, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead-zinc ore.	Copper-lead ore.	Total.
Cochise	131,287	1,000,709	4,666	.....	.....	.....	1,136,662
Coconino and Maricopa	3,317	94	.....	.....	.....	.....	3,411
Gila	68	442,238	78	.....	.....	46	442,430
Graham	2,589	1,505,655	43	.....	.....	.....	1,508,287
Mohave	75,085	569	359	695	.....	.....	76,708
Pima	196	132,285	138	.....	.....	38	132,657
Pinal	3,433	417	46	.....	.....	.....	3,896
Santa Cruz	497	403	52	.....	.....	.....	952
Yavapai	81,499	232,538	76	.....	.....	.....	314,113
Yuma	77,529	232	61	.....	.....	.....	77,822
Total	375,500	3,315,140	5,519	695	.....	84	3,696,938
Value per ton in gold and silver	$5.32	$0.53	$15.64	$2.91	.....	$23.49	.....

GOLD.

The gold output of Arizona for 1908, as reported by the producers, aggregated 117,646.89 fine ounces, valued at $2,431,977. Compared with the figures of 1907, this indicates a decrease of 8,965.63 ounces in quantity and of $185,336 in value. The principal gold-producing mines are located in Yavapai, Mohave, Cochise, and Yuma counties. Decreased production is noted in all of the counties except Cochise

and Yuma. Mohave County shows the greatest decrease in 1908, due to the diminished output of the Gold Roads property. Nearly half of the gold produced in Arizona was extracted from ore treated at 61 gold and silver mills, aggregating 224,270 tons, yielding 55,276.31 ounces of gold, and averaging in value per ton $5.09. Some of the ores treated in these mills contained base metals, which were saved by concentration, and 9,018 tons of such ores contained copper, lead, and zinc, and yielded 658 tons of lead-copper concentrates, averaging $14.10 per ton in gold. From 6,366 tons of ore, containing small quantities of lead, there were produced 243 tons of lead concentrate, averaging $131.68 per ton in gold. From ores containing auriferous iron pyrite, 5,631 tons of concentrate yielded an average of $25.23 per ton in gold. All but 30 tons of the ore that produced concentrate as well as bullion was the yield of mines in Yavapai County. Mills in Arizona, equipped only for concentration, treated 1,454,767 tons and saved 252,605 tons of concentrates, containing 12,624.26 ounces of gold, valued at $260,966, or an average value per ton of $1.03. The concentrates were of two kinds, one containing chiefly copper and the other lead. The copper concentrates contained little gold, the average per ton in 1908 of the total tonnage being less than 3 cents. The largest amount of gold reported per ton of concentrates was $30.59. Lead concentrates, 1,671 tons in quantity, were obtained from 47,096 tons of ore, which produced an average of $20.67 per ton of concentrates, or a total of 1,671.62 ounces of gold. In the crude ore directly smelted, 1,810,078 tons in quantity, the yield in gold was 48,172.04 ounces, valued at $995,804, or an average value of 55 cents per ton. The gold yield from the placer mining in 1908 amounted to $30,937, a decrease of $13,954 from that reported in 1907. Yavapai, Yuma, and Pima counties produced the largest quantities of placer gold, most of which was recovered by dry washing and some sluicing. The small dredge on Lynx Creek, in Yavapai County, did not operate, but on Agua Fria River, in Maricopa County, material was hauled for the construction of a dredge.

The largest gold producers in 1908, named in order of importance, were the United Verde, in Yavapai County; the King of Arizona, in Yuma County; the Congress, at Congress, in Yavapai County; and the Tom Reed, near Gold Road, in Mohave County. Development work has been started on the Vulture mine, a former gold producer, in Maricopa County.

Source of gold production in Arizona by kinds of ore in 1908, by counties, in fine ounces.

County.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead-zinc ore.	Copper-lead ore.	Total.
Cochise	8.71	7,451.49	17,501.71	643.85	.....	.....	.....	25,605.76
Coconino and Maricopa	83.06	514.19	2.26	.....	.....	.....	.....	599.51
Gila	.....	60.42	2,543.72	7.81	.....	.....	38.03	2,649.98
Graham	31.83	397.21	959.47	.....	.....	.....	.....	1,388.51
Mohave	.....	14,089.72	1.84	134.67	80.00	.....	.....	14,306.23
Pima	201.00	99.25	141.53	6.73	.....	.....	1.43	449.94
Pinal	26.12	668.55	3.63	5.36	.....	.....	.....	703.66
Santa Cruz	14.42	54.84	5.65	.....	.....	.....	2.10	77.01
Yavapai	660.61	32,922.89	20,375.75	65.61	.....	.....	.....	54,024.86
Yuma	470.83	17,264.99	104.80	.81	.....	.....	.....	17,841.43
	1,496.58	73,523.55	41,640.36	864.84	80.00	.....	41.56	117,646.81

Comparison of these totals for 1908 with the gold output for 1907 is as follows:

Mine production of gold in Arizona in 1907 and 1908, by kinds of ore, in fine ounces.

Year.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead-zinc ore.	Copper-lead ore.	Total.
1907	2,171.60	80,505.12	41,829.37	2,043.55	13.94	.....	48.94	126,612.52
1908	1,496.58	73,523.55	41,640.36	864.84	80.00	.....	41.56	117,646.89
Increase (+) or decrease (−)	−675.02	−6,981.57	−189.01	−1,178.71	+66.06	.....	−7.38	−8,965.63

SILVER.

The yield of silver amounted to 2,808,450 ounces, valued at $1,488,478. Compared with the figures of 1907, this indicates an increase of 296,553 ounces in quantity and a decrease of $169,374 in value. The output of silver came mainly from copper ores, from which source were derived 1,777,266 ounces, about half of which, or 882,500 ounces, was from copper ores produced from mines in Cochise County, and from that kind of ore over one-fourth more silver was produced than in 1907. Siliceous ores produced 899,072 ounces, or about one-third of the total. This output was 77,294 ounces less than the production of 1907. Silver also decreased in production in 1908 from copper-lead ore and copper-lead-zinc ore. The largest producers of silver in 1908 were the United Verde, in Yavapai County, and the Copper Queen, Commonwealth, and Tombstone mines, in Cochise County. The last was first in production in 1907, but fell to fourth in 1908. The crude ore treated at smelters, 1,810,078 tons in quantity, yielded 2,075,262 ounces of silver, averaging 1.15 ounces per ton. Gold and silver mills treated 224,270 tons of ore, yielding 516,367 ounces, contained in bullion from amalgamation and cyanide operations, and averaging 2.30 ounces per ton. These mills, some of which were equipped with concentrators, saved three kinds of concentrate, lead-copper, lead, and iron pyrite, in addition to the bullion secured by amalgamation and cyanidation. Of the first kind of concentrate 658 tons were saved, yielding 8,920 ounces of silver, averaging 13.55 ounces per ton, and recovered from 9,018 tons of crude ore. Of the second, 243 tons were saved with 12,843 ounces of silver, averaging 52.85 ounces per ton, the yield of 6,366 tons of crude ore. Of the third, 5,631 tons of concentrate yielded 22,372 ounces of silver, averaging 3.97 ounces per ton. The first and second kinds of concentrate were from Yavapai County, and the third was promiscuously distributed. At concentration mills 252,605 tons of concentrates were made, yielding 205,444 ounces of silver, or an average of 0.81 of an ounce per ton. The copper concentrate contained but little silver. Globe district, in Gila County, reported the largest total quantity. The average recovery, however, from Globe was only 0.58 of an ounce per ton. From 1,671 tons of lead concentrates, recovered from 47,096 tons of ore produced in Cochise, Mohave, and Yavapai counties, were obtained 127,031 ounces of silver, averaging 76.02 ounces per ton. Cochise, the leading county in silver

production, is credited with 1,630,749 ounces, valued at $864,297 in 1908, as against 1,411,301 ounces, valued at $931,459 in 1907, an increase of 219,448 ounces in quantity. This and Pima County showed the largest increases in silver recorded in Arizona. Development work was reported on the famous Stonewall Jackson mine, which, previous to 1887, was one of the most productive silver mines in Gila County. In Pinal County the Silver King mine was also being developed. Small test shipments of silver ore from the property were made in 1908.

Source of silver production in Arizona, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead-zinc ore.	Copper-lead ore.	Total.
Cochise	1	697,832	822,500	110,416	.....	.....	.....	1,630,749
Coconino and Maricopa	17	98	234	.....	.....	.....	.....	349
Gila	.....	339	163,912	379	.....	.....	270	164,900
Graham	8	48,348	76,167	8	.....	.....	.....	124,531
Mohave	.....	28,735	3,129	6,863	700	.....	.....	39,427
Pima	22	2,762	205,007	5,594	.....	.....	1,394	214,779
Pinal	4	573	3,187	1,672	.....	.....	.....	5,436
Santa Cruz	1	8,864	6,108	305	.....	.....	440	15,718
Yavapai	99	105,009	495,909	1,628	.....	.....	.....	602,645
Yuma	106	6,512	1,113	2,185	.....	.....	.....	9,916
	258	899,072	1,777,266	129,050	700	.....	2,104	2,808,450

Comparison of these totals for 1908 with the silver output for 1907 is as follows:

Mine production of silver in Arizona in 1907 and 1908, by kinds of ore, in fine ounces.

Year.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead-zinc ore.	Copper-lead ore.	Total.
1907	365	976,600	1,416,964	112,923	519	1,728	2,798	2,511,897
1908	258	899,072	1,777,266	129,050	700	.....	2,104	2,808,450
Increase (+) or decrease (−)	−107	−77,528	+360,302	+16,127	+181	−1,728	−694	+296,553

COPPER.

In 1908 the output of copper in Arizona amounted to 285,858,133 pounds, valued at $37,733,273. Compared with the figures of 1907, this was an increase of 30,978,644 pounds in quantity and a decrease of $13,242,625 in value. Decreases are recorded in Pinal, Coconino, Yuma, and Maricopa counties, each affected by the closing of smelters at Humboldt, in Yavapai County, and of the Saddle Mountain smelter at Christmas, in Gila County. Santa Cruz County also suffered by the closing of the smelters at Washington and Mowry. The starting of operations at Sasco by the Southern Arizona Smelting Company and the additions to the two copper smelters at Douglas contributed largely to the increased output. In 1908 Graham County held second place in the Territory as a producer of copper, Gila third, and Yavapai fourth, each in the same order as in 1907, but with a greatly increased production. Cochise County, however,

is credited with over four-tenths of Arizona's output, or 126,554,764 pounds. Compared with the figures of 1907, this showed an increase in 1908 of 16,529,838 pounds, and forms with the output of Graham County, credited with an increase of 14,428,117 pounds, the largest part of the copper increase in Arizona. The ore treated at smelters, or 1,810,078 tons, which included lead ore, contained 215,469,458 pounds of copper, or an average of 119 pounds per ton, equivalent to 5.95 per cent. In addition to the crude ore treated at smelters, 143,675 tons of old slag were smelted, and yielded 9,146,486 pounds of copper, averaging 63.66 pounds, or 3.18 per cent per ton. The total quantity of concentrates produced in Arizona was 252,605 tons, of which 248,376 tons, or about nine-tenths, contained 61,215,831 pounds of copper, an average of 250.5 pounds per ton, or 12.52 per cent of copper. The concentrates were produced in the following counties, named according to importance of output, Graham, Gila, Pima, and Yavapai, and represented 1,399,897 tons of crude ore mined and concentrated, but they did not include ore treated at gold and silver mills, which produced, besides bullion, 658 tons of concentrates, containing 19,539 pounds, and averaging per ton 29.7 pounds of copper, which were produced by 4 properties in Big Bug district, in Yavapai County. In Globe district of Gila County the Miami Copper Company reported that 12,000,000 tons of 2.5 per cent copper ore have been developed. Other investigations of the same character are being made near Kelvin, in Pinal County, by the Ray Consolidated and other companies.

LEAD.

The output of lead decreased from 4,660,684 pounds, valued at $247,016, in 1907, to 3,008,583 pounds, valued at $126,360 in 1908. Cochise County still held first place with 1,978,097 pounds, and was followed by Yavapai County with 362,334 pounds, whereas Mohave County was second in rank for 1907. The last county took third place in total output, which decreased from 1,229,654 pounds in 1907 to 254,013 pounds in 1908. Crude ore shipped directly to smelters contained about two-thirds of the total output, or 1,963,198 pounds. Concentrates, containing lead produced at concentration mills, aggregated 1,671 tons and contained 872,825 pounds of lead, averaging 522.3 pounds of lead per ton of concentrates, or 26.11 per cent. The concentrates were produced in Cochise, Yavapai, and Mohave counties, named in order of importance in the output of lead, and represented 47,096 tons of crude ore mined and concentrated; this quantity does not include some ore treated at gold and silver mills containing lead which was saved in concentrates. These aggregated 901 tons and contained 172,560 pounds of lead, averaging 191.5 pounds per ton. Yavapai County mines were the only producers of lead in concentrates, which came from mills in Big Bug, Hassayampa, Tiger, and Weaver districts. Two-thirds of the lead concentrates contained some copper. Santa Cruz County was first in the production of silver-lead ore in 1907, principally from mines near Mowry and Harshaw, but none of these properties did much in 1908. In Cochise County the output was principally carbonate ore from Hendricks Gulch, in the vicinity of the Bisbee copper mines, where small deposits are encountered in the limestone. Mohave County mines near Chloride produced some lead.

ZINC.

The zinc output reported for Arizona in 1908, estimated as spelter, aggregated 678,446 pounds, valued at $31,887. This was derived from Mohave and Cochise counties, each recording the product of one property. Yavapai and Santa Cruz counties recorded production in 1907, and under better prices of the metal will probably produce again. Crude zinc ore formed the major portion of shipments from Mohave County, the remainder of the production being shipped as concentrate from Cochise County.

MINING INDUSTRY IN ARIZONA IN 1908.

The financial troubles of 1907 left a cloud of industrial depression hanging over the country, and its effect was felt in Arizona during the greater part of 1908, but it had little or no effect on any of the older mining establishments. Cessation of work was principally by the small operators, and these were largely gold miners in all the counties, which had the effect of diminishing the total gold production. Arizona in 1908 continued first in the production of copper, surpassing Montana and Michigan. The most notable developments were those which are still opening up large tonnages of low-grade copper ore in the Globe district, Gila County, and at Ray, in Pinal County. Courtland, in the Dragoon Mountains, in Cochise County, is a new copper camp. It is situated about 20 miles northeast of Tombstone, near Gleeson. The Calumet and Arizona and the Copper Queen Mining companies are known to be interested there in properties containing large bodies of low-grade copper ore. The recent announcement that a railroad would be built from Courtland to Douglas has stimulated mining in that locality. A number of old mines in other parts of the Territory, which were thought to be exhausted, have been reopened during the year. These were the Vekol silver-lead mines, 35 miles southwest of Casa Grande, in Pima County, the Vulture in Maricopa County, the Silver King in Pinal County, and the Harqua Hala in Yuma County. The southern part of Yavapai County, northeastern Maricopa County, and Yuma County have been made accessible for low-grade mining by new railway facilities mentioned in previous reports. The railroad from Wickenburg to Parker, across northern Yuma County, gives access to that mineral region hitherto remote and neglected. Two milling plants were started in the San Francisco district of Mohave County on the Tom Reed and the Victor gold mines, but the former was somewhat hampered by litigation, though it did well in producing gold bullion. The Victor Company closed its plant, it is said on account of litigation, after operating a short time. A 100-ton concentration mill is being constructed on the property of the Minnesota-Arizona Copper Company in Bunker Hill district, Pinal County, and the mill of the United Gold Mines Company at Congress, in Yavapai County, was completed, as was the North Star mill in Yuma County. In the Silver Bell district, of Pima County, the concentration plant for the treatment of the low-grade porphyry ores of the Imperial mine was partly constructed in 1907, but it had not been put in operation at the close of 1908. The ore mined goes entirely to the smelter of the Southern Arizona

Smelting Company, whose plant was successfully started early in 1908 and continued throughout the year. The material for the Mitchell smelter, which was unloaded at Globe and never erected, was transported during 1908 to the Clara property in northern Yuma County. The unwatering of the Tombstone silver mines was continued at the rate of 5,000 gallons per minute, pumped from the 1,000-foot level. More ore has been extracted and shipped from the lower levels of this property than ever before. At Benson, Boston interests having control of the lead smelter built there by the Southwestern Smelting Company several years ago were reported to be actively engaged in making contracts for ore during the latter part of 1908.

Arizona has 13 counties, from 11 of which mine operators reported production of metals in 1908. Eighty-two mining districts have a production credited to them for 1908, against 95 recorded in 1907.

Mine production of gold, silver, copper, and lead in Arizona in 1908, by counties.

County.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Pounds.*	
Cochise	25,605.76	$529,318	1,630,749	$864,297	126,554,764	$16,705,229
Coconino and Maricopa	599.51	12,393	349	185	24,561	3,242
Gila	2,649.98	54,780	164,900	87,397	37,380,914	4,934,281
Graham	1,388.51	28,703	124,531	66,001	77,149,079	10,183,678
Mohave	14,306.23	295,736	39,427	20,896	345,491	45,605
Pima	449.94	9,301	214,779	113,833	7,909,976	1,044,117
Pinal	703.66	14,546	5,436	2,881	99,380	13,118
Santa Cruz	77.01	1,592	15,718	8,331	83,277	10,992
Yavapai	54,024.86	1,116,793	602,645	319,402	36,248,440	4,784,794
Yuma	17,841.43	368,815	9,916	5,255	62,251	8,217
	117,646.89	2,431,977	2,808,450	1,488,478	285,858,133	37,733,273

County.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Cochise	1,978,097	$83,080	173,313	$8,146	$18,190,070
Coconino and Maricopa					15,820
Gila	70,487	2,960			5,079,418
Graham	30,255	1,271			10,279,653
Mohave	254,013	10,668	505,133	23,741	396,646
Pima	129,405	5,435			1,172,686
Pinal	25,995	1,092			31,637
Santa Cruz	85,015	3,571			24,486
Yavapai	362,334	15,218			6,236,207
Yuma	72,982	3,065			385,352
	3,008,583	126,360	678,446	31,887	41,811,975

Tonnage of milling and smelting ore and concentrates, and quantity of gold and silver contained in bullion, produced in Arizona in 1908, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Cochise	59,679	5,233.20	488,835	45,866
Coconino and Maricopa	3,317	514.18	98	.....
Gila	22	37.66	4	126.886
Graham	200	43.01	4	1,270,976
Mohave	10,030	13,078.24	6,778	232
Pima	177	59.06	34	1,729
Pinal	3,427	663.65	148	.....
Santa Cruz	410	40.72	27	.....
Yavapai	69,495	18,555.46	14,013	9,078
Yuma	77,513	17,051.13	6,426	.....
	224,270	55,276.31	516,367	1,454,767

County.	Concentrates produced.						Total value of concentrates.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	1,492	1,309.89	121,759	.....	809,574	173,313	133,758
Coconino and Maricopa	.....	.....	.....	.....	.....	.....	.....
Gila	39,824	.97	23,279	5,583,222	.....	.....	749,343
Graham	208,357	233.45	10,220	55,555,278	.....	.....	7,343,540
Mohave	112	225.29	1,096	.....	19,008	14,813	6,732
Pima	163	57.41	2,193	75,252	.....	.....	12,282
Pinal	.....	.....	.....	.....	.....	.....	.....
Santa Cruz	.....	.....	.....	.....	.....	.....	.....
Yavapai	2,657	10,797.25	46,897	21,618	216,803	.....	260,013
Yuma	.....	.....	.....	.....	.....	.....	.....
	252,605	12,624.26	205,444	61,235,370	1,045,385	188,126	8,505,668

County.	Crude ore to smelter.						Total value.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine. ounces.*	*Fine. ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	1,031,087	18,976.26	1,017,183	126,554,764	1,168,523	.....	17,685,688
Coconino and Maricopa	94	2.27	234	24,561	.....	.....	3,413
Gila	172,841	2,611.35	133,469	22,723,877	70,487	.....	3,127,233
Graham	236,147	1,080.22	114,299	21,514,311	30,255	.....	2,924,068
Mohave	2,298	1.002.70	31,553	345,491	235,005	490,320	115.970
Pima	130,751	132.47	212,530	7,834,724	129,405	.....	1,154,997
Pinal	469	13.89	5,284	99,380	25,995	.....	17,297
Santa Cruz	542	21.87	15,690	83,277	85,015	.....	23,333
Yavapai	235,540	24,011.54	541,636	36,226,822	145,531	.....	5,571,482
Yuma	309	319.47	3,384	62,251	72,982	.....	19,679
	1,810,078	48,172.04	2,075,262	215,469,458	1,963,198	490,320	30,643,160

The following table shows, by counties, the tons of ore sold or treated, the number of deep mines producing, the average total value per ton, and the average value per ton in gold and silver:

Tons of ore sold or treated, number of deep mines producing, and value of ores in 1907 and 1908, by counties.

County.	Ore sold or treated (short tons).		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	1908.	Increase (+) or decrease (−) compared with 1907.	1907.	1908.	1907.	1908.	1907.	1908.
Cochise	1,136,662	+ 55,676	47	26	$21.70	$16.00	$1.26	$1.23
Coconino and Maricopa	3,411	− 5,317	15	5	11.72	4.13	1.45	3.19
Gila	442,430	− 2,430	41	24	16.88	11.48	.28	.32
Graham	1,508,287	+ 89,788	34	29	8.91	6.81	.06	.06
Mohave	76,708	+ 7,821	49	42	11.99	5.17	9.27	4.13
Pima	132,657	+ 75,118	42	25	24.81	8.80	1.29	.90
Pinal	3,896	− 16,015	30	22	14.11	7.98	2.14	4.33
Santa Cruz	952	− 14,193	21	20	11.42	25.41	2.35	10.11
Yavapai	314,113	− 61,285	91	67	23.26	19.81	4.13	4.53
Yuma	77,822	+ 642	23	19	4.20	4.82	3.86	4.68
	3,696,938	+129,805	393	279	15.55	11.30	1.19	1.05

[a] Value per ton, placer product excluded.

The table following gives the number of mines, classified according to their chief product in 1908:

Number of mines in Arizona classified by chief products in 1908.

County.	Total mines, producing.	Gold placer mines.	Deep mines.										
			Gold.	Silver.	Copper.	Gold and silver.	Gold, silver, and copper.	Silver-copper.	Silver-copper-lead.	Gold, silver, and lead.	Silver and lead.	Gold, silver, copper, and lead.	Gold, silver, lead, and zinc.
Cochise	27	1	....	....	2	2	7	3	1	2	2	6	1
Coconino	2	....	....	....	....	....	1	1	....	....	....	....	....
Gila	24	....	....	1	1	4	6	7	1	3	1	....	....
Graham	30	1	....	....	10	10	3	2	....	1	1	2	....
Maricopa	5	2	1	....	....	2	....	....	....	....	....	....	....
Mohave	42	....	1	1	....	21	2	1	....	10	2	2	[a] 2
Pima	27	2	....	1	1	2	4	5	3	1	....	8	....
Pinal	23	1	....	....	1	4	4	6	2	2	....	3	....
Santa Cruz	21	1	....	....	1	3	8	4	....	1	1	2	....
Yavapai	79	12	1	1	1	39	8	1	....	13	....	3	....
Yuma	30	11	1	....	....	9	5	1	....	....	1	2	....
	310	31	4	4	17	96	48	31	7	33	8	28	3

[a] One reported also copper.

PRODUCTION BY COUNTIES.

COCHISE COUNTY.

Mine production of gold, silver, and associated metals in Cochise County, Ariz., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	21,070.21	$435,560	25,605.76	$529,318	+ 4,535.55	+ $93,758
Silver.....do....	1,411,301	931,459	1,630,749	864,297	+ 219,448	− 67,162
Copper.....pounds..	110,024,926	22,004,985	126,554,764	16,705,229	+16,529,838	−5,299,756
Lead.....do....	1,654,773	87,703	1,978,097	83,080	+ 323,324	− 4,623
Zinc.....do....	.....	.....	173,313	8,146	+ 173,313	+ 8,146
	.....	23,459,707	.....	18,190,070	.....	−5,269,637

Source of gold and silver in Cochise County, Ariz., in 1907 and 1908, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Gold	1907	40.44	9,199.06	11,581.72	248.71	0.28	21,070.21
	1908	8.71	7,451.49	17,501.71	643.85	.....	25,605.76
Silver	1907	11.00	791,464.00	592,535.00	26,800.00	491.00	1,411,301.00
	1908	1.00	697,832.00	822,500.00	110,416.00	.....	1,630,749.00

The gain in copper, from 110,024,926 pounds in 1907 to 126,554,764 pounds in 1908, was a noticeable feature in the mineral production of Cochise County. This was largely due to the improved equipment at the Bisbee mines and the smelters at Douglas. The total tonnage of ores produced by 26 operators in 1908, against 47 in 1907, amounted to 1,136,662 tons. This was an increase of 55,676 tons over the output reported in 1907. The total average value per ton decreased from $21.70 in 1907 to $16 in 1908, and although the value of $1.23 per ton for the gold and silver in 1908 was but 3 cents lower than in 1907, the remainder of the value was largely for the content of copper. Of the tonnage produced in 1908, about nine-tenths, or 1,031,787 tons, was treated at smelters and yielded 18,976.26 ounces of gold, 1,017,183 ounces of silver, 126,554,764 pounds of copper, and 1,168,523 pounds of lead. The lead was contained in 4,666 tons of ore, which was treated at a lead plant outside the Territory, and the remainder of the tonnage was almost all treated at the two copper plants at Douglas. The ore shipped to smelters aggregated in value $17,685,688, or an average assay value of $17.14 per ton. Ores treated at gold and silver mills aggregated 59,679 tons, and produced bullion containing 5,233.20 ounces of gold and 488,835 ounces of silver. The larger part of this output was the yield of mills using the cyanide process. Ores treated in concentrating mills amounted to 45,866 tons, from which were produced 1,492 tons of concentrates, yielding 1,309.89 ounces of gold, 121,759 ounces of silver, 809,574 pounds of lead, and 173,313 pounds of zinc, all shipped to plants outside of the Territory, and aggregating in value $133,758, an average value per ton of $89.65. Of copper ores 1,000,709 tons were produced, practically all of it in

the Warren district, and the dry or siliceous ores, aggregating 131,287 tons, nearly all came from mines in the Tombstone and Turquoise districts. Small quantities of copper, lead, and zinc were recovered from the ore of 2 properties in the last two districts. According to Graton[a] the primary ore of the Warren district, which consists of pyrite with chalcopyrite and possibly bornite, replaces limestone, and is commonly regarded as the result of contact metamorphism. The copper of the primary ores has been in part concentrated by the process known as "secondary enrichment" into workable ore bodies of varying size and of irregular shape. The ores consist mainly of carbonates, oxides, chalcocite, chalcopyrite, and pyrite, all being in places more or less intimately mixed. The percentage of sulphide ore mined is increasing. These ores are all smelted at Douglas. At Tombstone the ore deposits described by Weed[b] present quartzose veins filling fault fissures, cutting slightly tilted sedimentary rocks, with the workable ore bodies formed by replacements of limestone along bedding planes.

California district.—Three operators mining copper and lead ores in 1908 reported an aggregate output of 73 tons, containing but a trace of gold, 1,511 ounces of silver, 144 pounds of copper, and 6,122 pounds of lead. The Columbia group produced a small quantity of lead-silver ore. From the Humboldt mine, a producer of copper ore, and from the Savage property, were shipped small quantities of ore. The latter property is opened by a shaft (230 feet deep) and a tunnel. It is equipped with a 50-ton matting furnace, which has not been operated since it was erected.

Cochise district.—The principal metal produced in 1908 was copper, reported by 3 deep mines, which yielded 449 tons of ore containing no gold, 1,172 ounces of silver, 68,024 pounds of copper, and 1,161 pounds of lead, the total valued at $9,649, an average of $21.48 per ton. The deepest shaft, attaining 800 feet, is on the property of the Arizona and Michigan Development Company, which did not produce in 1908. Some ore was shipped from the mine dumps of the Peabody and some was mined from the property of the Arizona Consolidated Mining Company.

Dos Cabezas district.—The production of ore from this district in 1908 aggregated 112 tons, the larger part of which went direct to smelters and the remainder was treated at a gold and silver mill. The yield from the total was 48.09 ounces of gold, 192 ounces of silver, 60 pounds of copper, and 1,079 pounds of lead, valued at $1,149, an average of $10.26 per ton. The largest operator doing development work was the Mascot Copper Company. Some work was also carried on in Apache Pass on the Lulu property. The ore treated contained free gold and produced a lead concentrate, besides gold and silver bullion.

Hartford district.—Development, which has been carried on in the Butte and Arizona property by a 4,000-foot tunnel, has been discontinued. No production is recorded for the district in 1908.

Operators of the Sitric mine, in the Huachuca Mountains, closed their 100-ton cyanide plant the early part of 1908 without reporting a production. It is stated that the equipment of the mill is not adequate for crushing the ores.

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[a] Graton, L. C., Mineral Resources U. S. for 1907, pt. 1, U. S. Geol. Survey, 1908, p. 593. See Ransome, F. L., Prof. Paper U. S. Geological Survey No. 21, 1904, for description of Bisbee ore deposits.

[b] Weed, Walter Harvey, Trans. Am. Inst. Min. Eng., vol. 31, 1901, p. 648.

Teviston district.—The operators of the Gold Nuggett and the Happy Hooligan, and the Mineral Park Company reported development during the year. Some lead ore is said to have been shipped from near San Simon, Ariz., by the Big Springs Mining Company, now defunct. No other output was reported from the district.

Tombstone district.—The total output of this district in 1908 consisted of 51,266 tons of ore, yielding $84,866 in gold, 357,414 ounces of silver, 7,608 pounds of copper, 1,770,794 pounds of lead, and 173,313 pounds of zinc, the total valued at $357,818, an average of $6.98 per ton. This production came from the deep mines, of which 6 were reported in 1908. The larger part of the output, or 45,866 tons, was treated at a concentration mill, yielding lead concentrates and zinc concentrates, besides gold and silver bullion extracted by the cyanide process from the tailings. There were shipped direct to smelters 5,370 tons of crude ore. The largest and most important producer was the Tombstone mines; the Hershell and the Mouse Bird mines also recorded productions of silver-lead ore.

Turquoise district.—This district includes the new mining camp of Courtland, a possible large producer of copper ores, near Gleeson, and Pearce, the terminus of the Arizona and Colorado Railroad, a branch of the Southern Pacific. The immediate prospect of a railroad into Courtland has stimulated mining to a large extent. There were produced 59,649 tons of siliceous gold-silver ores, 24,578 tons of siliceous copper and silver ores, and 42 tons of copper ore in 1908. The aggregate yield of these ores was $81,335 in gold, 443,009 ounces of silver, 69,716 pounds of copper, and 16 pounds of lead, having a total value of $325,334, an average of $3.86 per ton. Four producers reported in 1908, the 2 principal mines being the Copper Belle at Gleeson and the Commonwealth mines at Pearce. From the former was shipped 80 tons of sulphide ore per day to the Shannon smelter at Clifton, and the latter is producing siliceous ore underground and in open cuts. A production of 200 tons of ore daily, which is treated by the cyanide process, is said to average about $3 per ton in gold and silver. The Leadville property was a small producer of copper ore, taken out in development. It has been estimated that 50,000 tons of ore of commercial grade were opened up. A new shaft has been sunk 250 feet. The Great Western Mining Company, at Courtland, started development in April. It has 2 vertical shafts 288 and 230 feet deep, respectively. The Calumet and Arizona Mining Company and the Great Western are working on bodies of copper carbonate in a manganese gangue. The deposit is in limestone cut by intrusive rocks, and the geological conditions, as well as the actual developments, are said to have considerable promise. The Tejon mine has 1,193 feet of drifts, including the tunnel 174 feet long. Copper ore in this property, aggregating 48,000 tons, is said to be blocked out.

Warren (Bisbee) district.—This district produces principally copper ores, with less lead, and small quantities of siliceous gold ore. The output of 1908 was reported by 6 producers, who shipped copper ore to smelters at Douglas and lead ore to El Paso. The aggregate yield from 1,000,479 tons of ore was $361,981 in gold, 827,379 ounces of silver, 126,409,212 pounds of copper, and 195,829 pounds of lead, having a total value of $17,494,733, and an average value of $17.48 per ton. At Bisbee preparations have almost been completed to

hoist by a skip the ore from every section of the Copper Queen mine through the new Sacramento shaft, then to load all cars by belt and tripper, and by this means to secure a uniform mixture. At the Calumet and Arizona mines a new shaft was started in November on a line between the Hope and the Wagner claims for the purpose of developing these 2 claims, which adjoin the Shattuck-Arizona property. Development work during 1908 consisted of a total of 20,680 feet in the Oliver, Irish Mag, and Wagner claims. The deepest workings, 1,350 feet, are on the Oliver. The production of ore from the property was 265,344 dry tons of smelting ore with an average recovery of 5.27 per cent of copper. The refined copper recovered in 1908 amounted to 28,048,329 pounds. The product of gold and silver was valued at $234,358.07, averaging $16.72 per ton of refined copper. At Douglas, the Calumet and Arizona works were not only enlarged, but were rearranged to meet the increased demand made on them by the production of the Superior and Pittsburg mines. At the Superior and Pittsburg Copper Company's property development work on the Cole, Junction, and Hoatson mines aggregated 29,572 feet. The shafts of the last 2 mines were deepened by 207 feet and 252 feet, respectively. The Junction workings are 1,555 feet deep, and the Hoatson 1,680 feet. Production consisted of 214,847 tons of dry ore smelted, with an average recovery of 5.10 per cent of copper, or a total of 21,924,359 pounds of refined copper. On the Denn-Arizona property a shaft is 1,200 feet deep. Development in 1908, until August, consisted of diamond drilling on the 1,100-foot level. The Boston-Bisbee Mining Company is the present owner of the Modern property with a shaft 200 feet deep. Lessees worked the Mountain View property and shipped small lots of copper ore. An important tonnage of oxidized iron ore was shipped by the Shattuck-Arizona Company, taken out in development, which, in 1908, consisted of 3,500 feet of drifts and raises. Most of the work was done on the 600-foot level. The vertical shaft is 900 feet deep.

COCONINO COUNTY.

Two producers reported in 1908 an output of 94 tons of copper ore. This is less by 6,839 tons than the production of 1907, which was reported by 10 operators. All of the ore was shipped to smelters and contained 2.27 ounces of gold, 234 ounces of silver, and 24,561 pounds of copper, aggregating in value $3,413, an average value of $36.31 per ton. The mining districts yielding low-grade copper ores were inactive on account of the low price of copper and the closing of the Humboldt smelter, near Prescott. The districts producing these ores, the Francis and the Canyon, are situated north of the Santa Fe Railroad. Near the Colorado River, at Supai, in Cataract Canyon, the Bridal Veil claims were worked and a small jig was erected on the property for concentrating the carbonate lead ore, which is mined from the limestone beds. Concentrates were made, but none were shipped.

GILA COUNTY.

The returns for 1908 in Gila County showed a decrease in tonnage of 2,430 tons; and the number of operators, which in 1907 was 41, was only 24 in 1908. The production of ore in 1908 aggregated

442,430 tons, the larger part of which was copper ore, the remainder being 68 tons of siliceous ore, 78 tons of lead ore, and 46 tons of copper-lead ore. Included with the ore was an important tonnage of old slag, the metal contents of which are included in the totals. The smelter at Globe treated a large part of the crude ore produced, which, with that shipped to outside plants, aggregated 172,841 tons, containing 2,611.35 ounces of gold, 133,469 ounces of silver, 22,723,877 pounds of copper, and 70,487 pounds of lead, with a total value of $3,127,233 and an average value of $18.09 per ton. At concentrating mills in the county 126,886 tons of ore were treated, yielding 39,824 tons of concentrates, containing 0.97 ounce of gold, 23,279 ounces of silver, and 5,583,222 pounds of copper, valued at $749,343, an average of $18.82 per ton.

Globe district.—The great producers of copper ore in 1908 were the Old Dominion, United Globe, Gibson, Warrior, Superior, Boston, Arizona Commercial, and Globe Consolidated companies. Others shipping ore were the operators of the Copper and Silver Zone mines, in Stony Gulch, and of the Radium mines and the Richmond Basin mine. Important development has been continued by the Miami Copper Company throughout 1908. A new 16 by 18 foot 6-compartment shaft is being sunk. Work on a large concentrator was to be begun early in 1909. The company estimates more than 10,000,000 tons of copper ore with an average content of about 3 per cent of copper. This low-grade copper deposit consists of disseminated secondary sulphides in schist. The shaft on the recently reopened Stonewall mine, at McMillan, has reached a depth of 150 feet. This old silver property was one of the largest producers of silver in the county in 1887.

Lost Gulch district.—The Lost Gulch Consolidated Mines Company shipped a small tonnage of lead-copper ore during 1908 to the El Paso smelter from the Cedar Tree property.

Pinto Creek district.—The Cracker Jim and Independent properties were productive of copper ore carrying silver values. The latter property is developed by a shaft 320 feet deep.

San Carlos district.—The Saddle Mountain Mining Company's copper matting furnace at Christmas was idle during the entire year.

GRAHAM COUNTY.

Mine production of gold, silver, and associated metals in Graham County, Ariz., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	1,476.07	$30,513	1,388.51	$28,703	− 87.56	− $1,810
Silver.....do....	87,578	57,801	124,531	66.001	+ 36,953	+ 8,200
Copper.....pounds..	62,720,962	12,544,192	77,149,079	10,183,678	+14,428,117	−2,360,514
Lead.....do....	14,142	750	30,255	1,271	+ 16,113	+ 521
	.....	12,633,256	.....	10,279,653	.....	−2,353,603

Source of gold and silver in Graham County, Ariz., in 1907 and 1908, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Siliceous ore.	Copper ore.	Copper-lead ore.	Total.
Gold	1907	19.98	228.71	1,225.27	2.11	1,476.07
	1908	31.83	397.21	959.47	.....	1,388.51
Silver	1907	3.00	22,596.00	64,859.00	120.00	87,578.00
	1908	8.00	45,348.00	76,167.00	[a] 8.00	124,531.00

[a] No copper reported.

Substantial gains are of record for Graham County in its tonnage of ore mined and of copper, silver, and lead produced in 1908 as compared with 1907. The total tonnage of ore mined, aggregating 1,508,287 tons, increased 89,788 tons. In 1908, 29 operators reported as against 34 in 1907, and the average value per ton decreased from $8.91 per ton in 1907 to $6.81 in 1908. Of the ore produced, 2,589 tons, containing small quantities of silver, were shipped to the smelters for use as converter lining, and 43 tons, classed as lead ore, were shipped to plants outside of the Territory. The greater part of the tonnage, or 1,270,976 tons, was treated at the concentration mills in the county, and yielded 208,357 tons of concentrates, containing 233.45 ounces of gold, 10,220 ounces of silver, and 55,555,278 pounds of copper, aggregating in value $7,343,540, an average of $35.25 per ton. Ore mined and shipped direct to the smelter, nearly half of which was treated in the county, amounted to 236,147 tons, containing 1,080.22 ounces of gold, 114,299 ounces of silver, and 21,514,311 pounds of copper; and the lead ore, which was shipped to outside plants, contained 30,255 pounds of lead. The metals aggregated in value $2,924,068, an average of $12.38 per ton. Included in this total were the contents of 964 tons of old slag and a small quantity of copper precipitates. The placer production had a total value of $662. With the exception of some of the ores of Shannon Mountain, the old shallow bodies of high-grade oxidized ore derived from contact metamorphic replacements in limestone have been exhausted. A great part of the production comes at the present time from large disseminated bodies and stock works of chalcocite along shattered zones in altered porphyry.[a]

Ash Peak district.—This district, located near the New Mexico-Arizona line, produced in 1908 1,203 tons of ore, which yielded $1,165 in gold and 28,403 ounces of silver, valued at $16,219, with an average value of $13.48 per ton. The Commerce and Shamrock properties were worked the entire year and 200 feet of shaft work were accomplished, making the total depth 500 feet. The ore shipped from these properties contains principally silver, and is used at the smelters for converter lining.

Copper Mountain and Greenlee district.—The Arizona, the Detroit, and the Shannon copper companies are the principal producers. Experimental work in cyaniding the ores of the Crawford Gold Mining Company was carried on during the year, and a small amount of bullion was shipped.

Lone Star district.—On the Fumarole property the shaft has attained a depth of 723 feet. Active development work was carried on the entire year.

[a] Graton, L. C., Mineral Resources for 1907, pt. i, U. S. Geol. Survey, 1908, p. 595.

MARICOPA COUNTY.

The only large producing property in this county was the Relief mine, near Phoenix. The county deep-mine production was valued at $10,629 for gold and $52 for silver. Placer production had a value of $1,726.

Agua Fria district.—The Relief Gold Mining Company operated its Lane mill intermittently during the year, producing the usual amount of gold bullion. It is said that there is not sufficient water to permit the constant operation of the plant.

Cave Creek district.—A number of properties were developed during 1908, and a small production of gold and silver was reported from several of them, notably from the Silver Moon and the Phoenix properties. A crosscut tunnel was being driven on the Ben Hur property. The Fort Worth mine was being equipped with a small milling plant, expected to be in operation in 1909. A little placer mining is carried on at times by transient prospectors when water is plentiful. The bullion is reported by the merchants.

San Domingo district.—Merchants trading for placer gold reported $787 in gold and 4 ounces of silver.

Vulture district.—The principal mining property, the Vulture, has long been idle on account of litigation, but was being put into shape for operation during the latter part of the year. It was reported that the 80-stamp mill was being repaired, and 10 stamps were expected to be started early in 1909. The mine is developed by 2 incline shafts 600 feet and 400 feet deep. Drifting has been started on the various levels below 350 feet reached by former owners. The ores formerly mined by the Vulture Company contained an average of $5 in gold, the larger part of which was free, and the remainder was contained in iron pyrite.

MOHAVE COUNTY.

The ore output in 1908 was 76,708 tons, which was 7,821 tons more than was produced in 1907. There were 42 producers in 1908 against 49 in 1907. The ore mined contained $295,736 in gold, 39,427 ounces of silver, 345,491 pounds of copper, 254,013 pounds of lead, and 505,133 pounds of zinc, having a total value of $396,646, an average value of $5.17 per ton in 1908, as against $11.99 in 1907. Decreases were recorded for all metals, except zinc. The gold production comes almost entirely from fissures in the tertiary eruptives of the Black Mountain Range. The remainder of the total output of the county was divided between the Cerbat Range and the Bently mining district, in the extreme northern part of the county, where a copper ore replacing limestone is found. The output of metal credited to the Cerbat Range, which includes the Wallapai, the Gold Basin, and the Maynard districts, was 1,262.64 ounces of gold and 29,967 ounces of silver; and all the copper, lead, and zinc, given elsewhere, were mined from fissures in the granitic rocks. The ore deposits of the Cerbat and Black Mountain ranges are described by Schrader.[a] The largest part of the production in 1908 was from the treatment of tailings, included in the total figures for the county. There were also treated at gold and silver mills 10,030 tons of ore, containing 13,078.24 ounces of gold and 6,778 ounces of silver. Ore shipped direct to smelters aggregated

[a] Schrader, F. C., Bull. U. S. Geol. Survey No. 340, 1908, pt. 1, pp. 59–82.

2,298 tons, and yielded 1,002.70 ounces of gold, 31,553 ounces of silver, 345,491 pounds of copper, 235,005 pounds of lead, and 490,320 pounds of spelter. The last was contained in zinc ore shipped outside the Territory, and the other ores were mostly treated at the lead smelter at Needles, Cal. The contents of the smelting ore were valued at $115,970, averaging $50.46 per ton. Concentrates produced from 232 tons of crude ore amounted to 112 tons, containing 225.29 ounces of gold, 1,096 ounces of silver, 19,008 pounds of lead, and 14,813 pounds of zinc, valued at $6,732, an average value of $60.11 per ton.

Bently district.—Production was reported by only 1 property, the Grand Gulch. The mine is opened by a vertical shaft 425 feet deep, and the ore bodies are said to occur as replacements in limestone in the vicinity of a network of irregular fissures. Shipments of ore aggregating 538 tons in 1908 averaged about 32 per cent copper and 4 ounces of silver per ton, all of which went to the Salt Lake smelters by way of Moapa, Nev.

Cottonwood district.—The Copper Giant claim is developed by a shaft 182 feet deep, in which was encountered copper ore said to contain $8 in gold and 8 per cent of copper. Although a producer in 1907, no output was reported from this mine for 1908.

Gold Basin district.—The Cyclopic and the Gold Belt were the principal properties operated, and a small production of bullion was made, which was extracted from ores taken out in the development of the properties.

Maynard district.—Very little activity was reported from this district during the year. The only property to produce was the Holy Moses group, owned by the Arizona Southwestern Copper Company, reporting a yield said to have resulted from the operation of a 3-stamp mill constructed the latter part of the year and operated on ore from the mine dump. Some concentrates were also produced, but were not shipped.

Music Mountain and Owens districts.—Both of the districts have productions credited to them in 1908, each from the operations of one company.

San Francisco district.—Six operators reported the treatment of 72,757 tons of ore, the larger part of which includes an estimate of the tailings treated by the Gold Roads Company. The total production consisted of $266,254 in gold and 6,522 ounces of silver. Aside from the Gold Roads property, the most important operator was the Tom Reed Gold Mines Company, whose property is equipped with a 10-stamp mill and a 40-ton cyanide plant. These were constructed previous to 1908 and operated from February to the end of the year. The property is developed by 3 incline shafts, the deepest of which is 250 feet. The Victor property was equipped with a 20-stamp and tube mill with cyanide plant having a capacity of 100 tons daily. This was operated during part of 1908, and it is understood financial troubles and litigation were the cause of closing the property indefinitely.

Wallapai district.—Although 22 producers reported to the Survey, only 2, the Chloride Gold Mining Company and the Union Basin Mining Company, had relatively large outputs. The ore, aggregating 2,179 tons, was divided into 1,102 tons of siliceous ore, 30 tons of copper ore, 353 tons of lead ore, and 694 tons of zinc ore. Of these ores,

200 tons were milled, yielding 60 ounces of gold and 140 ounces of silver; 232 tons were concentrated, making 95 tons of concentrates, containing 181.66 ounces of gold, 990 ounces of silver, 19,008 pounds of lead, and 14,813 pounds of zinc. Ore shipped direct to smelters, 1,747 tons in quantity, yielded 951.46 ounces of gold and 28,801 ounces of silver. The production of this district in base metals was 11,920 pounds of copper, 249,328 pounds of lead, and 505,133 pounds of spelter. The total metal output of the district was valued at $76,313 in 1908. At the Tennessee mine the waste dumps were partly worked over in a plant using jigs. Some lead concentrate was shipped. The Bi-Metal mine, operated by the Arizona Gold Mines Company, reported its 10-stamp mill in operation in January, 1909. The Golconda mine, of the Union Basin Mining Company, produced a zinc-lead ore. The crude ore from this property, containing principally zinc, was shipped to eastern plants, and the lead ore was shipped to smelters treating that class of product. The mine is developed by shafts and tunnels; the deepest shaft, 230 feet, is situated at Union Basin, 4 miles east of Mineral, a station on the branch railroad terminating at Chloride. The Idaho-Columbus Company, producing gold, silver, and zinc, developed ore and produced small quantities of concentrate. Other properties producing were the Chester, Lucky Boy, New London, Home Pastime, Rainbow, Redemption, St. Louis, and Tuckahoe.

Weaver district.—The managers of the Kemple property, on which a mill was recently installed, commenced operations the last month of the year, and reported the shipment of a small quantity of gold and silver bullion. The Dandy property, also equipped with a mill, produced some bullion.

PIMA COUNTY.

The deep mines producing, which numbered 42 in 1907, decreased to 25 in 1908; but the tonnage of ore mined and treated increased from 57,539 tons to 132,657 tons. Of the total tonnage, 132,285 tons consisted of copper ore, 196 tons of siliceous ore, 138 tons of lead ore, and 38 tons of copper-lead ore. The greater part of this tonnage, or 130,751 tons, was shipped to smelters, and yielded 132.47 ounces of gold, 212,530 ounces of silver, 7,834,724 pounds of copper, and 129,405 pounds of lead, the total being valued at $1,154,997, at an average of $8.83 per ton. There were 177 tons of ore treated at gold and silver mills, from which was extracted bullion containing 59.06 ounces of gold and 34 ounces of silver. Ore to concentration mills aggregated 1,729 tons, which yielded 163 tons of concentrates containing 57.41 ounces of gold, 2,193 ounces of silver, and 75,252 pounds of copper, valued at $12,282, an average of $75.35 per ton. The placer yield of the Greaterville and Quijotoa districts in 1908 was 201 ounces, against 425.70 ounces in 1907. The operation of the smelting plant of the Southern Arizona Smelting Company at Sasco was largely responsible for the increased copper output of Pima County in 1908.

Ajo district.—Various tests made by the Pima Ore Reduction Company on Cornelia copper ores resulted in the shipment of several lots of concentrate and some precipitate.

Amole district.—Only one small shipment was made from this district during 1908. The operators of the Gould mine, which was a producer in 1907, reported only development work for 1908.

Arivaca district.—The output was reported by 3 producers and aggregated only 13 tons of ore shipped to smelters, containing gold, silver, copper, and lead, valued at $629, an average of $48.38 per ton. The district is 65 miles from Tucson. A number of old properties are being opened.

Bavoquavari district.—One operator reported some gold and silver ore mined in 1908 from the Boston claim, near Tussi Creek. A new group of mining claims was being opened up by the Santa Rosa Copper Company, on which there is an incline shaft 100 feet deep.

Empire district.—Some ore containing principally lead with copper and silver has been taken out of a number of properties in the district during 1908, but only 1 is reported to have shipped ore.

Greaterville district.—As usual, an estimate has been placed on the amount of placer gold taken out by transitory miners working in the region during 1908. The yield, partly reported by banks and merchants, was valued at $3,109.

Helvetia district.—Three operators reported production, the largest of which was from the Helvetia property. Shipments began in December and averaged about 60 tons of copper ore daily. The Rosemont property and its 50-ton smelter were idle. The total output of the district aggregated 892 tons of ore shipped to the smelter, containing $61 in gold, 949 ounces of silver, 91,146 pounds of copper, and 374 pounds of lead, having a total value of $12,611, or an average value of $14.14 per ton.

Pima district.—The production reported by 9 operators amounted to 10,859 tons of ore mined and shipped to smelters, yielding $421 in gold, 12,619 ounces of silver, 1,078,390 pounds of copper, and 111,586 pounds of lead, having a total value of $154,143, an average value of $14.19 per ton. The largest producer was the Twin Butte mine. Ore was also shipped from the Esperanza, Chesterfield, Anna, and Plumed Knight mines.

Quijotoa district.—Little activity was reported from this district, and the production, aggregating in value $4,141 for gold, silver, and small quantities of copper and lead, included the gold estimated to have been produced by placers operated largely by lessees with dry washers.

Silver Bell district.—Four important properties aggregated a yield of 120,165 tons, which contained $2,011 in gold, 196,778 ounces of silver, and 6,712,530 pounds of copper, having a total value of $992,357, an average value of $8.26 per ton. All of this ore was treated at smelters, with the exception of 1,637 tons, which yielded 111 tons of concentrate containing 51,536 pounds of copper. The principal productions were made by the Imperial, Oxide, and El Tiro properties. The deepest vertical shaft on the Imperial property is 700 feet. Its 300-ton concentrator was not operated. All of the ores were shipped to Sasco, a few miles from the mine, and treated by the Southern Arizona Smelting Company. The El Tiro property has several shafts, the deepest one on which sinking is being continued being 300 feet. The concentrator was enlarged from a 50-ton experimental plant to a capacity of 100 tons and was in operation part of the year, accomplishing a very high extraction at low cost. The large ore deposits of the district occur in altered limestone near porphyry.

PINAL COUNTY.

The tonnage of ore mined in 1908 decreased 16,015 tons, and the average value per ton decreased from $14.11 in 1907 to $7.98 in 1908. The ore mined aggregated 3,896 tons, of which the larger part, or 3,427 tons, was treated at gold and silver mills, and yielded bullion containing 663.65 ounces of gold and 148 ounces of silver. Crude ore to smelters aggregated 469 tons and contained 13.89 ounces of gold, 5,284 ounces of silver, 99,380 pounds of copper, and 25,995 pounds of lead, valued at $17,297, averaging $36.88 per ton. The placer production consisted of 26.12 ounces of gold and 4 ounces of silver, worth $542.

Bunker Hill district.—No production was made from this district in 1908. A 100-ton concentration mill was built on the Minnesota-Arizona Copper Company's property.

Casa Grande district.—A production of 166 tons of ore all of which was shipped to smelters, was made by 4 operators in 1908, and contained $37 in gold, 3,961 ounces of silver, 39,834 pounds of copper, and 3,739 pounds of lead, the total value of which was $7,551, an average value of $45.49 per ton. The most important developments in the district have been in opening up the Vekol property, equipped with a mill which operated the last part of the year and produced some lead-silver concentrate. Other operations were carried on at the Jack Rabbit mine and on the Reward property.

Mineral Creek district.—The Ray Consolidated Copper Company at present has 11 large drills at work and is equipping a 300-ton experimental mill at Kelvin with different concentrating devices. The plant was in operation in the early part of 1909, testing low-grade copper ores. Large areas have been prospected with the churn drills and great tonnages of low-grade ore are estimated as available. The total production of the district in 1908 aggregated 24 tons of copper ore from one property.

Mineral Hill district.—The production is the aggregate of 5 small shipments to smelters from the district in 1908 of 44 tons of ore containing $47 in gold, 210 ounces of silver, 7,681 pounds of copper, and 10 pounds of lead, having a total value of $1,173, an average value of $26.66 per ton.

Old Hat district.—One placer and 3 deep-mine operators reported production from this district in 1908. There were 3,037 tons of ore treated at gold and silver mills and 5 tons shipped to a smelter. The aggregate output contained $12,773 in gold, 267 ounces of silver, and 522 pounds of lead, valued at $12,937. The Mohawk Gold Mining Company was the principal producer, reporting to the tax collector a production of 585.9 ounces of gold and 117 ounces of silver.

Pioneer district.—There was recorded in this district a production from 4 operators amounting to 68 tons of ore, all of which was shipped to smelters and contained $108 in gold, 317 ounces of silver, 5,098 pounds of copper, and 21,411 pounds of lead, with a total value of $1,848, averaging $27.19 per ton. The principal work was done on the White Elephant and Silver Queen properties.

Riverside district.—The production of 528 tons of ore, reported by 4 operators in 1908, was principally treated at gold and silver mills, and 138 tons were shipped direct to smelters. The aggregate yield amounted to $1,581 in gold, 666 ounces of silver, 26,968 pounds of

copper, and 313 pounds of lead. The properties furnishing the output were the Burns group, near Winkelman, yielding a copper-lead-silver ore, the Gold Coin, at Troy, and the Sultana.

SANTA CRUZ COUNTY.

Twenty operators in 1908 reported a production of 952 tons of crude ore. This was 14,193 tons less than the production of 1907, which was reported by 21 operators. The average value per ton in 1908 was $25.41, almost half of which, or $10.11, was the value of the gold and silver. Of the tonnage produced the larger part, aggregating 542 tons, went to smelters, and contained 21.87 ounces of gold, 15,690 ounces of silver, 83,277 pounds of copper, 85,015 pounds of lead, with a total value of $23,333 and an average value of $43.05 per ton. At gold and silver mills there were treated 410 tons of ore, yielding bullion containing 40.72 ounces of gold and 27 ounces of silver. The placer yield was 14.42 ounces of gold and 1 ounce of silver, valued at $299. Of the tonnage produced by deep mines 497 tons were siliceous ore, 403 tons were copper ore, and 52 tons were lead ore.

Harshaw district.—The World's Fair mine was the largest producer of silver in this district. The output of the district, partly estimated, was 138 tons of ore, which contained $49 in gold, 7,591 ounces of silver, and 23,299 pounds of copper, having a total value of $7,147, and an average value of $51.79 per ton.

Oro Blanco district.—Only development and assessment work was reported by 4 properties, and a small quantity of ore containing gold and silver was shipped as a test.

Patagonia district.—The 200-ton concentrator and the 100-ton reverberatory furnace of the Duquesne Mining and Reduction Company, also the lead smelter of the Santa Cruz Company, at Mowry, were idle. In the district 8 properties yielded 192 tons of ore, which was shipped to smelters and contained $548 in gold, 1,443 ounces of silver, 24,449 pounds of copper, and 5,882 pounds of lead, the total valued at $4,787, an average value of $24.93 per ton. Lead ore was shipped by the Arizona Pittsburg Mining Company, and copper ore from the Three R. and National properties. Small shipments were made also from a number of claims operated by lessees. The operators of the Four Metal mine did considerable development work, driving its main tunnel, which is over 700 feet long.

Tyndall district.—Three properties recorded an output of 407 tons of ore, all of which, with the exception of 23 tons shipped to smelters, was treated at gold and silver mills. The total output of the district was $587 in gold, 762 ounces of silver, 152 pounds of copper, and 61,327 pounds of lead, having a total value of $3,587, an average value of $8.81 per ton. The Santa Rita Mining Company erected a small 14-ton mill. This property is located in the Agua Caliente Canyon of the Santa Rita Mountains. On the Gringo mine in this district a 5-stamp mill was reported in operation, and additions were made to the plant.

Wrightson district.—The production of the district aggregated 214 tons of ore, the larger part of which was shipped to smelters, the remainder being treated at a gold and silver mill. The yield was $387

in gold, 5,852 ounces of silver, 35,377 pounds of copper, and 17,806 pounds of lead, having a total value of $8,907, an average value of $41.62 per ton. This output was reported by 6 operators. Some development work was carried on at the Augusta claim, during which lessees shipped copper ore. The property is being developed by a 200-foot shaft and a tunnel. Prospecting with a drill was carried on by the American Mining and Oil Company on the Castle Butte claims. One car of copper ore was shipped from the property. High-grade copper-silver ore was also shipped from the Ivanhoe claims, developed by a shaft 100 feet deep. The Happy Jack Mining Company, newly organized, produced a lead ore containing 42.3 per cent of that metal, 2.8 per cent of copper, and 20 ounces of silver per ton. The mine is developed by a shaft 200 feet deep and a tunnel 950 feet long. The 30-ton matte smelter of the Mansfield Company for treating the copper ore was nearly completed at the latter part of the year. A little work was done in the mine, which is developed by several shafts, the deepest being 360 feet. Shipments of ore have been made for experimental purposes.

YAVAPAI COUNTY.

Mine production of gold, silver, and associated metals in Yavapai County, Ariz., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	55,345.94	$1,144,102	54,024.86	$1,116,793	−1,321.07	− $27,309
Silver.....do....	647,488	427,342	602,645	319,402	− 44,843	− 107,940
Copper.....pounds..	35,734,416	7,146,883	36,248,440	4,784,794	+ 514,024	−2,362,089
Lead.....do....	521,307	27,629	362,334	15,218	− 158 973	− 12,411
Zinc.....do....	140,786	8,307	.....	.....	− 140,786	− 8,307
	.....	8,754,263	.....	6,236,207	.....	−2,518,056

The origin of the precious metals, by different kinds of ore, is given in the following table:

Source of gold and silver in Yavapai County, Ariz., in 1907 and 1908, in fine ounces.

Metal.	Year.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Gold	1907	1,014.95	28,086.80	25,511.31	732.88	.....	.....	55,345.94
	1908	660.61	32,922.89	20,375.75	65.61	.....	.....	54,024.86
Silver	1907	164.00	117,316.00	520,049.00	9,959.00	.....	.....	647,488.00
	1908	99.00	105,009.00	495,909.00	1,628.00	.....	.....	602,645.00

Conditions for normal production of metals in Yavapai County in 1908 were unfavorable. Few of the operators could ship to smelters outside of the county on account of high freight rates, which caused many of them to hold the product at the mines pending the opening of the smelter at Humboldt. Despite these conditions, however, the production showed but a small decrease in quantity, and this was

offset by the operations of many of the gold and silver mills. The ore mined aggregated 314,113 tons in 1908, as against 375,398 tons in 1907, and a decrease was also noted in the average value per ton from $23.26 in 1907 to $19.81 in 1908. Included in these values, the gold and silver, worth $4.13 in 1907, increased to $4.53 in 1908. Three-fourths of the ore mined, or 232,538 tons, was classed as copper ore, 81,499 tons as siliceous ore, and 76 tons as lead ore. The crude ore treated at smelters aggregated 235,540 tons and yielded 24,011.54 ounces of gold, 541,636 ounces of silver, 36,226,822 pounds of copper, and 145,531 pounds of lead, valued at $5,571,482, an average value of $23.65 per ton. The ore containing lead was shipped to Needles and El Paso, and the larger part of the copper ore produced from the mine of the United Verde Copper Company was treated in its smelter at Jerome. Gold and silver mills treated 69,495 tons of ore, yielding bullion which contained 18,555.46 ounces of gold and 14,013 ounces of silver, valued at $391,003, an average value of $5.62 per ton. Some of these mills were equipped with concentrators, but the tonnage of concentrates from that source was small. There were treated at concentration mills 9,078 tons of ore, which yielded 2,657 tons of concentrates. All of the concentrates yielded 10,797.25 ounces of gold, 46,897 ounces of silver, 21,618 pounds of copper, and 216,803 pounds of lead, valued at $260,013, an average value of $97.86 per ton. The placer yield, which came largely from Rich Hill, in the southern part of the county, and the Big Bug district, near Prescott, amounted to $13,708 for the output of 660.61 ounces of gold and 99 ounces of silver.

Agua Fria district.—Very little work, except assessment and some development work, was recorded in 1908. The Bauman Copper Company was preparing its property the latter part of the year for operation again.

Big Bug district.—The total output of this district, aggregating 13,429 tons, contained $161,271 in gold, 41,152 ounces of silver, 22,634 pounds of copper, and 292,383 pounds of lead, the total valued at $198,349, an average value of $14.77 per ton. Two-thirds of the tonnage, or 8,242 tons, was treated at concentration mills, yielding 853 tons of concentrates, which contained 2,471.01 ounces of gold, 14,069 ounces of silver, 21,040 pounds of copper, and 164,219 pounds of lead, valued at $68,211, and averaging $79.96 per ton. A part of these concentrates was from gold and silver mills. The crude ore of shipping grade, 2,623 tons in quantity, contained 2,973.12 ounces of gold, 25,999 ounces of silver, 1,594 pounds of copper, and 128,164 pounds of lead, having a total value of $80,832, and an average value of $30.81 per ton. Copper-silver ore and concentrate were shipped from the Gladstone property by lessees. The Lookout was a producer of lead ore. The Mount Elliot plant is equipped with concentrating tables. Some bullion, and concentrates containing lead, copper, and gold, were shipped. The Oriental mill treated some ores from old mine dumps. The Poland property continued to be the steadiest producer in the district. Its 20-stamp mill was in full operation during 1908, and lead-copper concentrate, in addition to the gold and silver saved on the plates, was produced and shipped. Concentrates of three kinds, lead, iron, and zinc, were made at the Poland mill. The latter grade was reserved for better metal prices.

Black Canyon district.—Of the ores produced in this district, containing principally gold and silver, there were treated at gold and silver mills 198 tons, which yielded 50 ounces of gold, 45 ounces of silver, and 19 tons of pyrite concentrate, yielding 34.01 ounces of gold and 38 ounces of silver. In addition to this, 70 tons of ore of shipping grade were sent to smelters and contained 104.58 ounces of gold and 380 ounces of silver. The output of the district was from four properties.

Black Hills district.—In this region three properties yielded 61 tons of ore and copper matte, which contained $119 in gold, 926 ounces of silver, and 34,060 pounds of copper, the total valued at $5,106, an average value of $83.70 per ton. The principal work in the district in the past has been done by the Yaeger Canyon Copper Company, equipped with a small matting furnace. The property was idle in 1908.

Black Rock district.—The largest producer of this district, the Interior Mining and Trust Company, closed its mill in July, but continued development work in the mine until the latter part of 1908. The incline shaft was sunk 210 feet, making a total depth of 752 feet. The mill, containing 12 Nissen stamps, amalgamation plates, and concentrators, produced bullion and pyrite concentrate, containing only gold and silver. Most of the concentrates were made in 1907, but were shipped in 1908. At the Monte Cristo property, owned by the Yavapai Silver Mines Company, the incline shaft is 221 feet deep. A small shipment of silver ore was made to the smelter. The Black Rock property went under new control in December, and new improvements were made in the mill. The mine is developed by an incline shaft 175 feet deep. The production consisted of a small lot of gold and silver ore. From the Grijalva and Unida properties, ore containing principally gold and a little copper was shipped. The total yield from five properties aggregated 10,604 tons of ore, which contained $91,749 in gold, 12,103 ounces of silver, and 3,626 pounds of copper, valued at $98,642. This output was divided into 10,552 tons of ore, treated at gold and silver mills, which yielded 490 tons of concentrates, and 52 tons of ore shipped direct to smelters.

Cherry Creek district.—Six deep mines yielded 464 tons of ore, the principal part of which was treated at gold and silver mills, only 25 tons being concentrated. The yield of metals was $5,775 in gold and 86 ounces of silver, valued at $5,821, an average value of $12.54 per ton. The producers were the Arizona Copper and Gold Mines Company, the Broom, Etta, Statehood, and Yavapai properties.

Copper Basin district.—The Logan Company has been deepening its shaft to 155 feet. A new organization, known as the Penn Arizona Mining Company, has taken hold of the Lancaster property and is doing some development work. No production was recorded.

Eureka district.—A production was expected, but did not materialize, from the Big Stick Gold Mining Company, which erected a 20-stamp concentration mill and 70-ton cyanide plant in 1907. It is reported that the plant will not be completed until the spring of 1909. Several vertical shafts, aggregating 650 feet, have been sunk on the property, and it is reported that a large tonnage of ore, containing gold and silver, is blocked out.

Hassayampa district.—There were 470 tons of ore produced by 10 operators in this district in 1908. The yield was $6,534 in gold, 595

ounces of silver, 4,453 pounds of copper, and 787 pounds of lead, valued at $7,470, an average value of $15.89 per ton. Nearly all of the ore, or 438 tons, was treated in gold and silver mills, and yielded 206.01 ounces of gold and 96 ounces of silver; also 18 tons of concentrate, containing 35.60 ounces of gold, 59 ounces of silver, and 787 pounds of lead. The ore of shipping grade, 32 tons in quantity, contained 74.47 ounces of gold, 440 ounces of silver, and 4,453 pounds of copper. During the year the Empire property was put in shape for production. Its old cyanide plant was dismantled, and concentrators were installed. The production consisted principally of gold bullion. The Climax Company also made shipments of gold bullion. Its mine is developed by a vertical shaft 1,600 feet deep and by a tunnel 3,700 feet long. A 10-stamp mill is on the property.

Martinez district.—The Congress, Gold Dollar, and Alaska groups were the principal producers of gold and silver in 1908. The total yield was 29,026 tons of ore reported by these companies, returning $186,922 in gold and 16,809 ounces of silver, having a total value of $195,831, and averaging $6.75 per ton. The equipment of the Congress mines has been described in former reports. The Alaska property, owned by the United Gold Mines Company, which has been developing it for the last seven years, has a milling equipment of 4 Nissen stamps, 3 Wilfley tables, and a cyanide plant. The production reported was the yield of concentrates from a test of 500 tons of ore in the new plant.

Peck district.—Silver-gold ore, 413 tons in quantity, reported by 4 operators, yielded $3,064 in gold and 6,454 ounces of silver, having a total value of $6,485, and an average value of $15.70 per ton. The Golden Belt mine was worked by lessees during the year. It is equipped with a 2-stamp Tremain mill and a Wilfley concentrator, and is situated on the lower part of Turkey Creek. The Lincoln Gold Mining Company operated its mill in May, producing bullion and concentrate, but closed down the remainder of the year.

Tiger district.—The principal operators were the Tiger and Savoy Mining companies, both producing gold and silver bullion, and one of the properties shipped a lead concentrate in addition. The aggregate yield reported by 4 operators was 5,374 tons of ore, which contained $43,046 in gold, 20,103 ounces of silver, and 16,096 pounds of lead, having a total value of $54,377, an average value of $10.12 per ton.

Turkey district.—Lead ore, with some gold and silver bullion, was the output of 2 deep mines and 1 placer property in this district, which aggregated a yield of $3,075 in gold, 778 ounces of silver, and 2,006 pounds of lead. At gold and silver mills 450 tons of ore were treated, yielding bullion and concentrate, the latter containing only gold and silver; the shipping ore consisted of 8 tons, containing the lead. Operators of the district developing and producing were the New Cumberland and the War Eagle companies.

Verde district.—The ore produced was entirely the output of one property, the United Verde, which reported to the territorial auditor a production of 36,183,089 pounds of copper, 20,334.09 ounces of gold, and 494,574 ounces of silver, having a total value of $5,460,818. The Cleopatra mines have been equipped with a smelting plant, but the delay in starting is said to be due to the lack of sufficient iron

flux for smelting the copper ores. The United Verde [a] mine is developed by 2 shafts 1,000 and 900 feet, respectively, also by 3 tunnels, one at the 300-foot, another at the 500-foot, and a third at the 1,000-foot level, the latter being completed in 1908. The blast-furnace plant consists of one 600-ton furnace, three 400-ton furnaces, and one 300-ton furnace, making the total capacity of the plant 2,100 tons daily. The Verde Grand Copper Company has developed its property to a depth of 838 feet.

Walker district.—Operators of 4 deep mines reported the shipment of 142 tons of ore to smelters, which contained 261.71 ounces of gold, 455 ounces of silver, and 5,860 pounds of lead. In addition to this 450 tons were treated at gold and silver mills and yielded 725.60 ounces of gold, 446 ounces of silver, and 69 tons of pyrite concentrates, containing 159.80 ounces of gold and 202 ounces of silver. Placer dust worth $5,148 for the gold and silver was reported by merchants purchasing it. Lessees operated the Bullwhacker property during part of the year. The Pine Mountain mine produced ore, which was treated in a 10-stamp mill. Its vertical shaft is 500 feet deep, and the tunnel is 325 feet long. Gold bullion and lead concentrates were shipped. Production and development work in the Senate mine were recorded, and some placer ground was worked in the same locality.

Weaver district.—This district is famous for its production of placer gold from Rich Hill, which did not produce as much in 1908 as in former years, but the yield, nevertheless, was important, $6,089 in gold and silver being reported. In addition there were 20,069 tons of ore treated at gold and silver mills, yielding 5,868.16 ounces of gold and 4,521 ounces of silver; also 160 tons of concentrates, containing 1,480.61 ounces of gold, 2,791 ounces of silver, and 38,914 pounds of lead. The shipments of ore to smelters aggregated 18 tons, containing only gold and silver. The principal producers were the Mildred Gold Mining Company, the Monica mine, and the Octave Mining Company. Important development work was carried on at the Alvarado Gold Mining Company's property, which is being equipped with a mill. No production was reported by the Rincon Mines Company, whose property is also equipped with a mill.

YUMA COUNTY.

The tonnage produced by 19 deep-mine operators in 1908 aggregated 77,822 tons, an increase of 642 tons as compared with that of 1907. The total yield from placers and deep mines was $368,815 in gold, 9,916 ounces of silver, 62,251 pounds of copper, and 72,982 pounds of lead. The total average value per ton of the ore mined showed an increase from $4.20 in 1907 to $4.82 in 1908, of which gold and silver formed the larger part, or $4.68 in 1908. Nearly all the ore produced in the county was treated by the cyanide process, the remainder being treated by amalgamation. The yield was $352,478 in gold and 3,406 ounces of silver. Crude ore shipped direct to the smelters aggregated 309 tons, containing 319.47 ounces of gold, 6,426 ounces of silver, 62,251 pounds of copper, and 72,982

[a] The geology and ore occurrences are briefly described by L. C. Graton, Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, p. 597.

pounds of lead, valued at $19,679, an average value of $63.68 per ton.

Castle Dome district.—The dry-placer diggings and 2 deep mines in this locality produced a total of $2,739 in gold, 1,668 ounces of silver, 9 pounds of copper, and 72,243 pounds of lead. The lead and copper and 1,644 ounces of silver, with only 0.10 of an ounce of gold, were recovered from 55 tons of ore shipped to smelters. Very little work was performed on the De Luce group of claims, from which only a few tons of mixed carbonate and sulphide lead ore were mined and shipped during the year. Development in the property has been carried on to a depth of 170 feet by an incline shaft.

Ellsworth district.—The operations of 2 deep mines and of dry placers resulted in the shipment of product valued at $23,320. The Bonanza and Golden Eagle and the Cunningham Pass properties were the only 2 producing deep mines operating in the district. The Cholla group and the property of the Corona Copper Company were both being developed. The Vicksburg Development Company started the construction of a 10-stamp mill in the latter part of the year. The ore from this property is a low-grade gold quartz, which is said to yield from $6 to $8 in gold per ton. About 1,000 feet of tunneling and shaft work has been completed. Northwest of Cunningham Pass the Oro Cobra property was being developed by a shaft. The 20-stamp amalgamation and concentration mill of the Socorro mine was idle.

Kofa district.—This district produced from deep mines and some dry placers in 1908 a total yield of $333,841 in gold and 6,177 ounces of silver. The King of Arizona Company operated its cyanide plant continually during 1908 and was the largest producer. The Golden Star Mining Company, operating the North Star mine, a new property, began operations in 1908. Its incline shaft is 300 feet deep, 200 feet of which were accomplished in 1908. The 50-ton cyanide and crushing plant was started in August and continued in successful operation for the remainder of the year.

Plomosa district.—Eight producers reported from this district in 1908 an output of 402 tons of ore, of which 250 tons were treated at a gold and silver mill and the remainder was shipped to smelters. The total recovery from these ores aggregated $7,065 in gold, 1,230 ounces of silver, and 40,326 pounds of copper. The bullion of dry-placer diggings was reported by dealers and merchants, who handled $2,050 in gold and 13 ounces of silver. The operators of the Excelsior, Copper Prince, and Arizona Success mines were the principal shippers. Development work only was reported by the Clara Consolidated Copper Company. A 400-ton smelter and a 40-ton converter plant were partly erected on its property during the year.

Cienega district.—The yield in 1908 came from the Pittsburg group, which produced lead-silver ore. The Quartz King Mining Company sunk a shaft to a depth of 238 feet, which encountered a heavy flow of water, necessitating the installation of pumping machinery. The ore contains gold and copper.

CALIFORNIA.

By Charles G. Yale.

PRODUCTION.

For the calendar year 1908 the California production of gold, silver, copper, and lead was valued at $24,805,141, as compared with $23,338,104 in 1907, an increase in 1908 of $1,467,037. This increase was mainly due to the augmented output of gold, though there was some increase in silver also; but the value of the copper and lead production was smaller than in 1907. The increase in gold was 98,376.90 fine ounces, valued at $2,033,631, and that in silver was 508,420 fine ounces. The increase in value of silver, however, was only $121,411; and although there was an increase in quantity of copper amounting to 10,248,861 pounds over the output of 1907, yet there was a decrease in value of $587,056. The lead and zinc showed both reduced quantities and values in 1908 as compared with those of 1907.

Reports were received from 1,054 producing properties, of which 495 were deep mines and 559 were placers of various descriptions. There were also reports received from 1,463 unproductive properties, on most of which more or less development work was being done. The deep mines may be classified by the relative quantities of metal produced, as follows: Gold, 464; silver, 2; gold and silver, 1; copper, 13; lead, 7; silver-lead, 6; and copper-lead, 2. Of the placer mines 145 are hydraulic, 69 dredge, 89 drift, and 256 surface or sluicing properties. The dredges are considered according to the number of machines at work in 1908, not by number of companies.

The 495 deep mines producing in the State in 1908 made an output of 2,546,908 tons of ore, 492,255 tons more than was produced in 1907. Of this output 2,025,594 tons were siliceous ore, 513,414 tons were copper ore, 7,532 tons were lead ore, and 368 tons were copper-lead ore.

The siliceous ore averaged $5.09 per ton in gold and silver; the copper ores, $1.99; the lead ores, $5.05; and the copper-lead ores, $2.35. The average yield in gold and silver from all the ores treated in the State in 1908 was $4.46 per ton.

The 2,546,908 tons of ore of all classes treated in the State in 1908 yielded 509,406.75 fine ounces of gold, valued at $10,530,372; 1,576,093 fine ounces of silver, valued at $835,329; 38,776,881 pounds of copper, valued at $5,118,548; and 1,237,548 pounds of lead, valued at $51,977. There was no zinc produced in California in 1908, though there was a small output in 1907.

The total value of the metals obtained from the ore treated in California in 1908 was $16,536,226, an average value per ton of $6.49. In 1907 the tonnage was 2,054,653 tons, and the total value $16,472,807, an average of $8.02 per ton; and in 1906 there were 2,556,056 tons treated, with a total valuation of $16,700,860, or $6.53 per ton. Thus while there were 492,255 more tons of ore treated in California in 1908 than in 1907 the average value per ton was $1.53 less in 1908 than in 1907.

In 1908 there were treated at gold and silver mills 1,863,871 tons of ore (including 384 tons sent to concentrating mills), containing $9,307,212 in gold, an average of $5 per ton, and silver valued at $148,028, an average of 8 cents per ton. This was a total of $9,455,240

in gold and silver, an average value per ton of $5.08 in both metals. This average value was $5.71 in 1907.

Of the total value, $7,669,613 in gold, averaging $4.12 per ton, and $128,434 in silver, averaging 7 cents per ton, a total of $7,798,047 in gold and silver, averaging $4.19 per ton in both metals, was recovered as bullion in the mills.

From the 1,863,871 tons of milling ore 31,976 tons of concentrates were obtained, valued at $1,637,599 in gold, an average of $51.21 per ton, and at $19,594 in silver, an average of 61 cents per ton. This is a total in gold and silver of $1,657,193, or an average value recovered from the concentrates of $51.82 per ton in gold and silver.

Of smelting ores there were 573,790 tons, valued at $883,116 in gold, an average of $1.54 per ton, and $631,576 in silver, an average of $1.10 per ton. The total yield of gold and silver in the smelting ores was $1,514,692, or an average of $2.64 per ton in gold and silver.

In addition to this there were 109,247 tons of old tailings treated, producing $340,044 in gold, an average of $3.02 per ton, and $55,725 in silver, an average of 51 cents per ton. The total gold and silver in the tailings was valued at $395,729, an average of $3.53 per ton in both metals.

In some counties the grade of ore milled is low but the quantities are large, while in other counties a higher grade of ore in smaller quantities is treated. Some exceptional high values in small lots of ore naturally affect the averages. For example, in one county in California, in 1908, less than a ton of ore from a certain mine yielded $85,000, and in another county another mine produced 1 ton of ore from which over $40,000 was recovered; in still another county 1 ton of ore yielded $35,000.

The 559 productive placer mines in California in 1908 yielded 398,183.67 fine ounces of gold, valued at $8,231,187, and 71,185 ounces of silver, valued at $37,728, a total value in gold and silver of $8,268,915. This was an increase of $1,403,618 over the output of 1907, mainly due to the dredging industry, which yielded $1,470,752 more in gold in 1908 than in 1907. The yield from hydraulic and drift mines fell off in 1908, but there was a much larger production from surface or sluicing mines. This increase may be more apparent than real, however, except in the case of the dredges, as it is not always possible for the Survey to get exact answers as to methods of working the auriferous gravels.

The statement of production in California for 1907 and 1908, showing increase or decrease and value at each year's commercial prices, is as follows:

Mine production of gold, silver, and associated metals in California in 1907 and 1908.

	1907.		1908.		Increase (+) decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	809,213.52	$16,727,928	907,590.42	$18,761,559	+ 98,376.90	+$2,033,631
Silver.....do....	1,138,858	751,646	1,647,278	873,057	+ 508,420	+ 121,411
Copper.....pounds..	28,528,020	5,705,604	38,776,881	5,118,548	+10,248,861	− 587,056
Lead.....do....	2,625,419	139,147	1,237,548	51,977	− 1,387,871	− 87,170
Zinc.....do....	233,550	13,779	.....	.....	− 233,550	− 13,779
	.....	23,338,104	.....	24,805,141	.....	+ 1,467,037

The following table shows the production of gold, silver, and associated metals in California in 1908, by counties:

Mine production of gold, silver, and associated metals in California in 1908, by counties.

County.	Gold.		Silver.		Copper.		Lead.		Grand total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		*Pounds.*		
Amador	90,759.92	$1,876,174	24,980	$13,239	55,788	$7,364			$1,896,777
Butte	151,868.38	3,139,398	23,978	12,708					3,152,106
Calaveras	66,685.47	1,378,511	118,353	62,727	4,473,030	590,440			2,031,678
Colusa	27.96	578	11	6					584
Del Norte	168.74	3,488	36	19	72,690	9,595			13,102
Eldorado	16,545.84	342,033	10,385	5,504					347,537
Fresno	50.99	1,054	21	11					1,065
Humboldt	1,599.57	33,066	613	325					33,391
Imperial	282.89	5,848	232	123	4,394	580			6,551
Inyo	14,941.73	308,873	58,302	30,900	3,690	487	1,110,952	$46,660	386,920
Kern	40,010.33	827,087	182,170	96,550	144	19			923,656
Lassen	352.36	7,284	1,477	783	205	27	7,143	300	8,394
Madera	2,182.05	45,107	2,385	1,264	61,030	8,056			54,427
Mariposa	21,278.33	439,862	8,928	4,732	36,757	4,852			449,446
Merced and Stanislaus	8,851.17	182,970	2,257	1,196					184,166
Mono	20,024.64	413,946	49,310	26,134			2,429	102	440,182
Monterey	63.76	1,318	17	9					1,327
Nevada	111,163.96	2,297,963	41,347	21,914					2,319,877
Placer	17,322.90	358,096	4,139	2,194					360,290
Plumas	12,322.90	254,737	6,717	3,560					258,297
Riverside	284.64	5,884	211	112	8,318	1,098			7,094
Sacramento	56,407.91	1,166,055	3,058	1,621					1,167,676
San Bernardino	8,732.22	180,511	67,366	35,704	201,993	26,663	117,024	4,915	247,793
San Diego	334.75	6,920	162	86					7,006
Shasta	54,752.37	1,131,832	976,596	517,596	33,852,842	4,468,575			6,118,003
Sierra	19,960.78	412,626	3,617	1,917					414,543
Siskiyou	24,388.55	504,156	11,557	6,125	6,000	792			511,073
Trinity	29,167.42	602,944	8,055	4,269					607,213
Tuolumne	38,639.63	798,752	22,136	11,732					810,484
Yuba	98,418.26	2,034,486	18,862	9,997					2,044,483
	907,590.42	18,761,559	1,647,278	873,057	38,776,881	5,118,548	1,237,548	51,977	24,805,141

GOLD.

The total gold production in California in 1908 was 907,590.42 fine ounces, valued at $18,761,559, as compared with 809,213.52 fine ounces, valued at $16,727,928, in 1907. The increase for 1908 was therefore 98,376.90 fine ounces, valued at $2,033,631. The deep mines of the State yielded 509,406.75 fine ounces of gold, valued at $10,530,372. Of this deep-mine gold, 486,210.01 fine ounces, valued at $10,050,853, was derived from siliceous ores; 22,885.83 ounces, valued at $473,092, from copper ores; and 310.91 ounces, valued at $6,427, from lead ores.

The total placer gold yield in 1908 was 398,183.67 fine ounces, valued at $8,231,187. Of this, $743,797 was derived from 145 hydraulic mines, $390,545 from 89 drift mines, $6,536,189 from 69 dredges, and $560,656 from 256 surface or sluicing mines. It will be seen from this that the dredges produced $4,841,191 more gold in 1908 than all the hydraulic, drift, and surface placers combined, or over 79 per cent of all the placer gold of the State for the year. In fact all the deep mines of California produced only $2,299,185 more gold than the combined placers in 1908. Had it not been for the dredging industry the output of placer gold in California would of late years have made a poor showing, especially since hydraulic

mining was prohibited in so many counties except under severely restrictive conditions. There were 69 dredges in California in 1908, operating in 8 of the counties. Butte County had 34 dredges, the largest number. It was not until after the close of 1898 that any production of moment was made by dredging operations. Since that time, the output of gold from that source has aggregated $25,385,571 and is steadily increasing as more dredges are built and set at work each year. The dredge-mining record in gold for the last ten years is shown as follows, with the increase or decrease for each year.

Value of gold won by dredging in California, 1899–1908, with increase (+) or decrease (−), by years.

1899	$206,302	
1900	200,929	− $5,373
1901	471,762	+ 270,833
1902	867,665	+ 395,903
1903	1,475,749	+ 608,084
1904	2,187,038	+ 711,289
1905	3,276,141	+1,089,103
1906	5,098,359	+1,822,218
1907	5,065,437	− 32,922
1908	6,536,189	+1,470,752
	25,385,571	

It was not until 1903 that the dredges first made an output exceeding that of either the hydraulic or drift mines. In 1904 the dredge yield exceeded the combined yield of the hydraulic and drift mines and greatly exceeded the yield of surface placers. In 1905 the dredges produced $461,205 more than the drift, hydraulic, and surface placers combined. Since 1905 the output of gold from dredges has continued far to exceed the yield of the three other forms of placer mining combined. It is to be noted that the reduction in yield from dredges in 1907 as compared with that of 1906 was owing to the fact that severe floods in 1907 reduced the working number of machines for a portion, at least, of that year. Some of the large dredges of recent construction are able to handle upward of 250,000 cubic yards monthly, and at an operating cost of less than 2 cents per cubic yard. They dig to a depth of 65 feet and pile débris 45 feet above the water level, a much greater range than was possible a few years ago. Moreover, streams of water under high pressure are in some instances now thrown against the banks through nozzles, breaking up and loosening any cemented gravel, thus greatly facilitating the work of the dredge buckets and increasing the daily digging capacity of the machines.

Of the 31 counties producing gold in California in 1908 there were 4 which yielded no placer gold and 3 which yielded no quartz gold. All the others produced gold from both deep and placer mines. There were 7 counties which yielded each over $1,000,000 in gold in 1908. The rank and value of output of these counties were as follows: Butte County, $3,139,398; Nevada, $2,297,963; Yuba, $2,034,486; Amador, $1,876,174; Calaveras, $1,378,511; Sacramento, $1,166,055, and Shasta, $1,131,832. Of these, Butte, Sacramento, and Yuba are dredge-mining counties and the others quartz-mining counties. It is worthy of note that the largest gold producer, Butte County, contained the greatest number of dredges at work.

As stated, the largest production of gold in California in 1908 came from Butte County, which also produced the largest amount from dredges. The leading hydraulic-mining county, as shown by the returns, was Trinity; the greatest producer from drift mines was Placer; and the largest output of gold from surface or sluicing mines was from Siskiyou. The largest production of gold from deep mines was from Nevada County—an output of $2,209,913. The highest tonnage of all classes of ores in the State was in Shasta County—556,922 tons; this county also had the largest tonnage of copper ores—457,055 tons. Calaveras County, with 427,470 tons, made the highest output of siliceous ore. The county which showed the largest increased yield of gold for the year was Sacramento, the increase in 1908 being $375,082. The greatest decrease, $240,008, was in Amador County. The counties of the State which produced more gold in 1908 than in 1907 showed a combined increase of gold product of $2,550,039, and those producing less gold showed a combined decrease of $516,408, the net increase of the State being $2,033,631.

The production of gold from placers and from different kinds of ore in California in 1908, by counties, in fine ounces, is given in the following table:

Source of gold production in California by kinds of ore in 1908, by counties, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ores.	Lead ores.	Total.	
Amador	949.02	89,672.74	138.16		89,810.90	90,759.92
Butte	151,216.72	651.66			651.66	151,868.38
Calaveras	11,686.38	51,543.08	3,456.01		54,999.09	66,685.47
Colusa		27.96			27.96	27.96
Del Norte	122.78		45.96		45.96	168.74
Eldorado	6,620.31	9,925.53			9,925.53	16,545.84
Fresno	1.98	49.01			49.01	50.99
Humboldt	1,529.43	70.14			70.14	1,599.57
Imperial	265.14		17.75		17.75	282.89
Inyo		14,656.41		285.32	14,941.73	14,941.73
Kern	1,085.68	38,924.65			38,924.65	40,010.33
Lassen		332.62		19.74	352.36	352.36
Madera		2,143.35	38.70		2,182.05	2,182.05
Mariposa	144.21	21,124.44	9.68		21,134.12	21,278.33
Merced and Stanislaus	8,851.17					8,851.17
Mono	17.51	20,007.13			20,007.13	20,024.64
Monterey	24.19	39.57			39.57	63.76
Nevada	4,259.42	106,904.54			106,904.54	111,163.96
Placer	12,918.11	4,404.79			4,404.79	17,322.90
Plumas	4,983.25	7,339.65			7,339.65	12,322.90
Riverside	24.19	255.95	4.50		260.45	284.64
Sacramento	56,407.91					56,407.91
San Bernardino	24.19	8,645.34	56.84	5.85	8,708.03	8,732.22
San Diego	21.91	312.84			312.84	334.75
Shasta	1,592.41	34,056.24	19,103.72		53,159.96	54,752.37
Sierra	5,303.40	14,657.38			14,657.38	19,960.78
Siskiyou	12,667.77	11,706.27	14.51		11,720.78	24,388.55
Trinity	20,187.37	8,980.05			8,980.05	29,167.42
Tuolumne	599.61	38,040.02			38,040.02	38,639.63
Yuba	96,679.61	1,738.65			1,738.65	98,418.26
	398,183.67	486,210.01	22,885.83	310.91	509,406.75	907,590.42

Comparisons of these totals for 1908 with the gold output of 1907 are as follows:

Mine production of gold in California in 1907 and 1908, by kinds of ore, in fine ounces.

	Placers.	Deep mines.					Grand total.	
		Siliceous ore.	Copper ores.	Lead ores.	Lead-zinc ores.	Total.	Quantity.	Value.
1907	330,918.62	461,147.80	16,661.37	459.75	25.98	478,294.90	809,213.52	$16,727,928
1908	398,183.67	486,210.01	22,885.83	310.91	.....	509,406.75	907,590.42	18,761,559
Increase (+) or Decrease (−)	+67,265.05	+25,062.21	+6,224.46	−148.84	−25.98	+31,111.85	+98,376.90	+2,033,631

The source of placer gold by counties and from various kinds of mines is shown as follows:

Source of placer gold in California in 1908, by counties.

County.	Hydraulic.	Drift.	Dredging.	Surface placers.	Total.
Amador	$13,490	$3,930	.....	$2,198	$19,618
Butte	12,736	13,878	$3,043,151	56,162	3,125,927
Calaveras	.....	22,413	198,600	20,566	241,579
Del Norte	2,202	.....	.....	336	2,538
Eldorado	2,600	38,148	.....	96,106	136,854
Fresno	.....	.....	.....	41	41
Humboldt	30,065	41	.....	1,510	31,616
Imperial and San Diego	.....	.....	.....	5,934	5,934
Kern	.....	.....	.....	22,443	22,443
Madera, Merced, and Stanislaus	.....	.....	182,970	.....	182,970
Mariposa	.....	.....	.....	2,981	2,981
Mono	.....	.....	.....	362	362
Monterey	.....	.....	.....	500	500
Nevada	45,890	28,030	.....	14,130	88,050
Placer	44,155	180,504	.....	42,382	267,041
Plumas	26,060	7,637	.....	69,316	103,013
Riverside	.....	.....	.....	500	500
Sacramento	569	52,365	1,109,196	3,925	1,166,055
San Bernardino	.....	.....	.....	500	500
Shasta	62	.....	30,966	1,890	32,918
Sierra	41,521	30,613	.....	37,497	109,631
Siskiyou	114,123	3,219	2,227	142,297	261,866
Trinity	409,781	375	.....	7,154	417,310
Tuolumne	.....	9,332	.....	3,063	12,395
Yuba	543	60	1,969,079	28,863	1,998,545
	743,797	390,545	6,536,189	560,656	8,231,187

The following table shows the increase or decrease of California gold production in 1908, by counties:

Increase and decrease in gold production in 1908, by counties.

County.	Increase.	Decrease.	County.	Increase.	Decrease.
Amador	.....	$240,008	Monterey	$242	.....
Butte	$352,558	.....	Nevada	135,880	.....
Calaveras	280,537	.....	Placer	.....	$124,676
Colusa	.....	156	Plumas	35,382	.....
Del Norte	2,610	.....	Riverside	2,048	.....
Eldorado	22,856	.....	Sacramento	375,082	.....
Fresno	.....	1,347	San Bernardino	21,835	.....
Humboldt	.....	7,043	San Diego	.....	535
Imperial	5,848	.....	San Luis Obispo	.....	316
Inyo	251,632	.....	Shasta	339,835	.....
Kern	.....	51,711	Sierra	.....	71,278
Lassen	7,284	.....	Siskiyou	106,139	.....
Los Angeles, Orange, and Ventura	.....	11,214	Trinity	67,628	.....
Madera	31,804	.....	Tuolumne	.....	8,124
Mariposa	34,364	.....	Yuba	267,716	.....
Merced and Stanislaus	178,784	.....	Total	2,550,039	516,408
Mono	29,975	.....	Increase	2,033,631	.....

SILVER.

The yield of silver in California in 1908 was 1,647,278 fine ounces, valued at $873,057. As compared with the production of 1907 this is an increase in quantity of 508,420 ounces and in value of $121,411. The larger part of the output, 1,031,381 fine ounces, valued at $546,632, was from smelting of copper ores, the siliceous ore yielding 483,483 fine ounces, valued at $256,246; from lead ores came 59,600 fine ounces, valued at $31,588, and from copper-lead ores 1,629 ounces, valued at $863. The largest quantity from siliceous ores, 181,657 ounces, valued at $96,278, came from Kern County. The largest producer of silver was Shasta County, which yielded from its copper ores 909,947 fine ounces, valued at $482,272, and from siliceous ore 66,362 ounces, valued at $35,172. With the silver from placers included, Shasta County produced altogether 976,596 fine ounces of silver, valued at $517,596. The silver obtained with the gold in placer mining amounted to 71,185 fine ounces, valued at $37,728. Butte County, with an output from dredging operations of 22,774 ounces, valued at $12,070, was the leading producer in placer silver. This silver is not considered in the output of dredges given in a preceding table. The following table shows the source of silver product in California in 1908, by placers and kinds of ore, by counties, in fine ounces:

Source of silver product in California by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Deep mines.					Grand total.
		Siliceous ore.	Copper ores.	Lead ores.	Copper-lead ores.	Total.	
Amador	808	19,949	4,223	.....	.....	24,172	24,980
Butte	22,774	1,204	.....	.....	.....	1,204	23,978
Calaveras	2,751	7,945	107,657	.....	.....	115,602	118,353
Colusa	.....	11	.....	.....	.....	11	11
Del Norte	36	.....	.....	.....	.....	.....	36
Eldorado	2,664	7,721	.....	.....	.....	7,721	10,385
Fresno	.....	21	.....	.....	.....	21	21
Humboldt	594	19	.....	.....	.....	19	613
Imperial	28	.....	204	.....	.....	204	232
Inyo	.....	8,376	.....	49,926	.....	58,302	58,30
Kern	513	181,657	.....	.....	.....	181,657	182,170
Lassen	.....	228	.....	1,249	.....	1,477	1,477
Madera	.....	1,576	809	.....	.....	2,385	2,385
Mariposa	43	8,523	362	.....	.....	8,885	8,928
Merced	1,415	.....	.....	.....	.....	.....	1,415
Mono	4	49,306	.....	.....	.....	49,306	49,310
Monterey	6	11	.....	.....	.....	11	17
Nevada	808	40,539	.....	.....	.....	40,539	41,347
Placer	2,977	1,162	.....	.....	.....	1,162	4,139
Plumas	5,223	1,494	.....	.....	.....	1,494	6,717
Riverside	7	180	24	.....	.....	204	211
Sacramento	3,058	.....	.....	.....	.....	.....	3,058
San Bernardino	9	49,262	8,041	8,425	1,629	67,357	67,366
San Diego	15	147	.....	.....	.....	147	162
Shasta	287	66,362	909,947	.....	.....	976,309	976,596
Sierra	1,515	2,102	.....	.....	.....	2,102	3,617
Siskiyou	6,538	4,905	114	.....	.....	5,019	11,557
Stanislaus	842	.....	.....	.....	.....	.....	842
Trinity	3,998	4,057	.....	.....	.....	4,057	8,055
Tuolumne	136	22,000	.....	.....	.....	22,000	22,136
Yuba	14,136	4,726	.....	.....	.....	4,726	18,862
	71,185	483,483	1,031,381	59,600	1,629	1,576,093	1,647,278

Comparisons of these totals for 1908 with the silver output of 1907 are as follows:

Mine production of silver in California in 1907 and 1908, by kinds of ore, in fine ounces.

	Placers.	Deep mines.						Grand total.	
		Siliceous ore.	Copper ores.	Lead ores.	Copper-lead ores.	Zinc-lead ores.	Total.	Quantity.	Value.
1907	37,276	410,903	607,726	66,691	600	15,662	1,101,582	1,138,858	$751,646
1908	71,185	483,483	1,031,381	59,600	1,629	.....	1,576,093	1,647,278	873,057
Increase (+) or decrease (−)	+33,909	+72,580	+423,655	−7,091	+1,029	−15,662	+474,511	+508,420	+121,411

COPPER.

The yield of copper in California in 1908 was 38,776,881 pounds, valued at $5,118,548. As compared with the figures of 1907 this was an increase in quantity of 10,248,861 pounds, but a decrease in value of $587,056. Copper was produced in 13 counties of the State in 1908, as compared with 10 counties in 1907. The heaviest production came, as usual from Shasta County, which made an output of 33,852,842 pounds, valued at $4,468,575. In 1907 this county produced 23,457,417 pounds, valued at $4,691,483. The increase in quantity in Shasta County in 1908 over that of 1907 was 10,395,425 pounds, but there was a decrease in total value amounting to $222,908. The next county in importance in 1908 in the production of copper was Calaveras, with an output of 4,473,030 pounds, valued at $590,440, followed in order by San Bernardino County, with a yield of 201,993 pounds, valued at $26,663. Other copper-producing counties were Amador, Del Norte, Imperial, Inyo, Kern, Lassen, Madera, Mariposa, Riverside, and Siskiyou. There were altogether 513,414 tons of copper ore treated in California in 1908, of which Shasta County yielded 457,055 tons. These copper ores also yielded 22,885.83 fine ounces of gold, valued at $473,092, and 1,031,381 fine ounces of silver, valued at $546,632. The total yield of the copper industry in 1908 in California in copper, gold, and silver amounted, in value, to $6,138,272.

LEAD.

The quantity of lead produced in California in 1908 was 1,237,548 pounds, valued at $51,997. This was a decrease in quantity, as compared with the production of 1907, of 1,387,871 pounds, and in value, of $87,170. The 4 counties of Inyo, Lassen, Mono, and San Bernardino were the chief producers in 1908, the largest quantity coming, as usual, from Inyo County, where there are 9 producing lead mines. In 1908 this county produced 1,110,952 pounds of lead, as compared with an output of 2,596,399 pounds in 1907, a falling off of 1,485,447 pounds. The lead ore treated in the State in 1908 was 7,532 tons, of which 7,356 tons came from Inyo County. With this lead were obtained 310.91 fine ounces of gold, valued at $6,427, and 59,600 ounces of silver, valued at $31,588.

ZINC.

There was no output of zinc in California in 1908, though in 1907 the output of the State was 233,550 pounds, valued at $13,799.

MINING INDUSTRY IN CALIFORNIA IN 1908.

In 1908 the value of the gold output was $2,033,631 more than it was in 1907, thus bringing California back to about its normal annual gold output of between $18,000,000 and $19,000,000. The silver output of the State also showed an increase in quantity, though there was only a small increase in value. There was an increase of over 10,000,000 pounds of copper, but the average price of the metal in 1908 was so low that the value received was more than $500,000 less than in 1907.

The total tonnage of ore treated in California in 1908 was 492,255 tons more than was handled in 1907, which showed an increased activity in deep mining. Generally speaking, the condition of the mining industry in California was satisfactory during 1908, especially in its gold mines, both deep and placer, though the low prices of silver, copper, and lead brought about reduced values.

There has been a marked revival in quartz mining for gold in many of the counties of the State, and a large amount of prospecting and development has been carried on. In the placer-mining industry the dredging interest is the only one which shows any material advance. The larger dredging fields are gradually getting into fewer hands, abundant capital being forthcoming to purchase suitable lands and build the modern machines necessary to carry on this class of work on an extensive scale. The increase of electric power plants throughout the State, where the mountain or foothill streams furnish the power, is having a marked effect on the mining industry in all its phases. The enlargement of the smelting industry in the State is also beneficial in giving miners a ready market for their ores and doing away largely with the necessity of individual reduction works. There has been agitation in several counties against the smelting plants on account of damage done by smelter smoke and fumes, and some litigation has resulted. The smelting companies have, however, attempted in every way to prevent the exit of these fumes from their stacks, and have paid for proved damages. They have also purchased much land in the vicinity of their plants. Organizations have, however, been formed in some of the counties where smelting plants are in operation which are intended to compel the owners to adopt preventive measures in the matter of smelter fumes.

The dredge operators also have met complaints that farms and lands along the river banks below their operations have been damaged by overflows during flood periods of the rivers, and this damage has been erroneously attributed to dredging work. Overflows in certain towns adjacent to where dredges are operating have also been laid to dredging work, it being asserted that the rock piles thrown up by the stackers of the machines have choked up the streams and prevented the rapid escape of waters during the spring months when freshets occur. A meeting of anti-dredge interests was called in Sacramento to protest against the continuance of gold dredging in the State. A committee was appointed to confer with the dredging companies and with the California Débris Commission. The latter

body, however, refused to interfere, declaring that they had no authority over dredging interests, being confined by law to supervision of hydraulic mining alone, and that in a certain specified district of the State only. The dredge miners soon convinced the committee that no damage had been done by their operations. Few of the dredges are working in river beds proper, and damages occurring came entirely from the natural spring floods, which brought down masses of débris and fine silt, more or less of which was deposited on lands near the river during the high waters. No dredges had deposited in the rivers anything which was not there before dredge operations began. One effect, however, of the whole discussion on the subject has been to cause the dredge owners to realize that they must defend their position and let the general public understand better the conditions under which they are operating and the advantages of the gold-dredging industry to the State. They can show that they take land otherwise absolutely valueless and make it directly productive. They are now taking out over $500,000 a month, mainly from what was previously unused, untaxed, and worthless ground. In some instances, of course, orchards or vineyards are destroyed, but the dredgers get as much out of the soil in a few months as horticulture would yield in fifty years. Moreover the larger dredging companies are now utilizing the much berated rock or dump piles by turning them into concrete or road material and then leveling off and replanting the ground so that it will again become productive on the surface, the gold beneath meantime having been dug out and put into general circulation. Details about all these and other facts are now being compiled through the medium of the larger dredging companies and will be published by a state institution.

There is much complaint from the hydraulic miners operating in the foothill and mountain districts of the drainage basin of Sacramento and San Joaquin rivers, where the Caminetti law applies to hydraulic mining, of the somewhat severe restrictions placed upon them by the officers comprising the present board of the California Débris Commission. Where formerly brush or log restraining dams were considered sufficient for impounding débris or tailings, concrete or stone dams are now required in many instances. Numbers of hydraulic mines have been compelled to close down, by order of the commission which is vested with this authority. Naturally there is little or no capital being invested in the hydraulic-mining industry where the details of operation are under control of parties not in interest.

Quartz mining in the Mother Lode section of California has always been a matter of interest to mining men, owing to the width, the productiveness, and the continuity of the gold-producing veins. In the section on "Production by counties" in this report the details of deep-mining work in Amador, Calaveras, Eldorado, Mariposa, and Tuolumne counties are given, with totals recovered from milling ores and concentrates and average values per ton. A condensed statement of the record for 1908 of these Mother Lode counties is given in the following table.

Tonnage of ore and value recovered in bullion in gold and silver mills, tonnage and value of concentrates produced, and total recovery, with average value per ton, in Mother Lode counties, California, in 1908.

County.	Ore to gold and silver mills.				Concentrates produced.				Total recovery.	Total average recovery per ton.
	Quantity.	Gold in bullion.	Silver in bullion.	Average value in gold and silver recovered on plates.	Quantity.	Gold.	Silver.	Average value in gold and silver.		
	Short tons.				*Short tons.*					
Amador	421,734	$1,214,776	$6,329	$2.90	8,934	$637,997	$4,240	$71.89	$1,863,342	$4.42
Calaveras	427,470	717,252	2,361	1.68	7,672	348,238	1,850	45.63	1,069,701	2.50
Eldorado	10,521	177,345	3,889	17.23	225	27,834	203	124.61	209,271	19.89
Mariposa	53,724	381,296	3,843	7.17	691	55,385	674	81.13	441,198	8.21
Tuolumne	263,211	488,830	9,435	1.89	9,334	296,637	2,200	32.02	797,102	3.03
	1,176,660	2,979,499	25,857	2.55	26,856	1,366,091	9,167	51.21	4,380,614	3.72

The total tonnage, by kinds of ore treated or sold in each county in California in 1908, is shown in the following table:

Subdivision of tonnage of crude ore sold or treated in California in 1908, by counties, in short tons.

County.	Siliceous ore.	Copper ores.	Lead ores.	Copper-lead ores.	Total ore.
Amador	421,747	408			422,155
Butte	1,215				1,215
Calaveras	427,470	54,199			481,669
Colusa	50				50
Del Norte		259			259
Eldorado	10,521				10,521
Fresno	81				81
Humboldt	534				534
Imperial		17			17
Inyo	32,084		7,356		39,440
Kern	259,968				259,968
Lassen	970		21		991
Madera	5,946	322			6,268
Mariposa	53,724	248			53,972
Mono	39,190				39,190
Monterey	40				40
Nevada	220,067				220,067
Placer	16,554				16,554
Plumas	29,537				29,537
Riverside	321	16			337
San Bernardino	23,829	830	155	368	25,182
San Diego	1,306				1,306
Shasta	99,867	457,055			556,922
Sierra	76,422				76,422
Siskiyou	19,970	60			20,030
Trinity	20,796				20,796
Tuolumne	263,216				263,216
Yuba	169				169
Total	2,025,594	513,414	7,532	368	2,546,908
Increase (+) or decrease (−)	+321,045	+174,262	−320	+328	+492,255
Average value per ton in gold and silver	$5.09	$1.99	$5.05	$2.35	$4.46

The subdivision of tonnage and production of gold and silver in California in 1908 according to methods of treatment is shown in the following table:

Subdivision of tonnage and production of gold and silver in California in 1908, according to methods of treatment, by counties.

County.	Ore to gold and silver mills.			Concentrates treated.		
	Tonnage.	Gold.	Silver.	Tonnage.	Gold.	Silver.
Amador	421,734	$1,214,776	$6,329	8,934	$637,997	$4,240
Butte	1,215	13,471	638			
Calaveras	427,470	717,252	2,361	7,672	348,238	1,850
Colusa	50	578	6			
Del Norte						
Eldorado	10,521	177,345	3,889	225	27,834	203
Fresno	81	1,013	11			
Humboldt	534	1,450	10			
Imperial	1	29				
Inyo	32,052	297,217	3,698	3	2,000	51
Kern	213,307	763,932	65,996			
Lassen	970	6,876	121			
Madera	5,946	42,067	637	41	2,240	198
Mariposa	53,724	381,296	3,843	691	55,385	674
Mono	26,463	165,230	6,631	138	5,440	113
Monterey	40	818	6			
Nevada	220,064	1,984,420	12,275	4,424	225,359	9,208
Placer	16,554	87,363	542	68	3,692	74
Plumas	29,537	151,724	792			
Riverside	321	5,291	95			
San Bernardino	1,537	20,935	320	45		596
San Diego	1,281	5,626	68	1	800	10
Shasta	43,030	422,375	2,620	147	14,748	87
Sierra	53,122	275,630	1,021	194	11,785	45
Siskiyou	19,800	232,015	2,514	9	1,088	10
Trinity	20,753	176,113	2,071	50	4,356	35
Tuolumne	263,211	488,830	9,435	9,334	296,637	2,200
Yuba	169	35,941	2,505			
Total	1,863,487	7,669,613	128,434	31,976	1,637,599	19,594
Average value per ton		4.12	0.07		51.21	0.61

County.	Crude ore to smelters.			Old tailings treated.		
	Tonnage.	Gold.	Silver.	Tonnage.	Gold.	Silver.
Amador	421	$3,783	$2,242			
Butte						
Calaveras	54,199	71,442	57,058			
Colusa						
Del Norte	259	950				
Eldorado						
Fresno						
Humboldt						
Imperial	16	338	108			
Inyo	3,562	8,807	24,572	3,826	$849	$2,579
Kern	7	753	81	46,654	39,959	30,201
Lassen	21	408	662			
Madera	322	800	429			
Mariposa	248	200	192			
Mono	60	49,281	25	12,667	193,633	19,363
Monterey						
Nevada	3	134	3			
Placer						
Plumas						
Riverside	16	93	13			
San Bernardino	5,485	69,053	31,249	17,800	90,023	3,534
San Diego	1	41				
Shasta	508,892	661,791	514,737	5,000		
Sierra				23,300	15,580	48
Siskiyou	230	9,187	136			
Trinity	43	5,165	44			
Tuolumne	5	890	25			
Yuba						
Total	573,790	883,116	631,576	109,247	340,044	55,725
Average value per ton		1.54	1.10		3.02	0.51

Average recovery per ton from bullion and concentrates: Gold $5, silver $0.08. There were 384 tons of crude ore sent to mills using concentration alone.

Reports were received from 2,517 mines in California in 1908, of which 1,054 were productive, and the others in course of development, idle, or held by assessment. There are on the California mine lists of the United States Geological Survey the names of 3,910 mines or mining companies, though many of them are small concerns under development or in the prospect stage.

Number of producing mines in California, classified by chief product, in 1907, by counties.

County.	Gold placer mines.					Deep mines.					Total mines reporting product.
	Hydraulic.	Dredging.	Drift.	Surface.	Total.	Gold.	Silver and silver-gold.	Copper.	Lead, silver-lead, copper-lead.	Total.	
Amador	2	.....	6	4	12	22	.....	.....	.....	22	34
Butte	1	34	11	25	71	4	.....	.....	.....	4	75
Calaveras	.....	3	12	12	27	30	.....	2	.....	32	59
Colusa	.....	.....	.....	.....	.....	1	.....	.....	.....	1	1
Del Norte	2	.....	.....	2	4	.....	.....	1	.....	1	5
Eldorado	3	.....	12	19	34	30	.....	.....	.....	30	64
Fresno	.....	.....	.....	1	1	4	.....	.....	.....	4	5
Humboldt	18	.....	1	2	21	2	.....	.....	.....	2	23
Imperial	.....	.....	.....	4	4	4	.....	.....	.....	4	8
Inyo	.....	.....	.....	.....	.....	18	.....	.....	7	25	25
Kern	.....	.....	.....	4	4	39	1	.....	.....	40	44
Lassen	.....	.....	.....	.....	.....	5	.....	.....	.....	5	5
Madera	.....	.....	.....	.....	.....	10	.....	1	.....	11	11
Mariposa	.....	.....	.....	2	2	23	.....	2	.....	25	27
Merced	.....	1	.....	.....	1	.....	.....	.....	.....	.....	1
Modoc	.....	.....	.....	.....	.....	2	.....	.....	.....	2	2
Mono	.....	.....	.....	1	1	10	.....	.....	.....	10	11
Monterey	.....	.....	.....	1	1	1	.....	.....	.....	1	2
Nevada	3	.....	3	7	13	35	.....	.....	.....	35	48
Placer	6	.....	12	25	43	13	.....	.....	.....	13	56
Plumas	11	.....	6	28	45	6	.....	.....	.....	6	51
Riverside	.....	.....	.....	1	1	4	.....	1	.....	5	6
Sacramento	1	12	3	4	20	.....	.....	.....	.....	.....	20
San Bernardino	.....	.....	.....	1	1	37	2	1	8	48	49
San Diego	.....	.....	.....	2	2	10	.....	.....	.....	10	12
San Luis Obispo	.....	.....	.....	1	1	.....	.....	.....	.....	.....	1
Shasta	1	2	.....	4	7	28	.....	4	.....	32	39
Sierra	6	.....	13	18	37	13	.....	.....	.....	13	50
Siskiyou	41	2	2	50	95	43	.....	1	.....	44	139
Stanislaus	.....	1	.....	.....	1	.....	.....	.....	.....	.....	1
Trinity	49	.....	3	14	66	24	.....	.....	.....	24	90
Tuolumne	.....	.....	4	4	8	42	.....	.....	.....	42	50
Ventura	.....	.....	.....	1	1	.....	.....	.....	.....	.....	1
Yuba	1	14	1	19	35	4	.....	.....	.....	4	39
	145	69	89	256	559	464	3	13	15	495	1,054

PRODUCTION BY COUNTIES.

AMADOR COUNTY.

Amador is the most productive of the Mother Lode counties of the State, but it did not reach the 2,000,000-dollar mark in value in 1908 as it did in 1907. The record of the county in metallic output in the last two years is as follows:

Mine production of Amador County, Cal., in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine oz.		*Fine oz.*		*Pounds.*		
1907	102,370.30	$2,116,182	20,477	$13,515	5,300	$1,060	$2,130,757
1908	90,759.92	1,876,174	24,980	13,239	55,788	7,364	1,896,777
Increase (+) or decrease (−)	−11,610.38	−240,008	+4,503	−276	+50,488	+6,304	−233,980

The increase shown is in quantity and value of copper. The falling off in yield of gold may be attributed entirely to the lessened output of the Fremont Consolidated Mining Company, the Keystone Consolidated Mining Company, the Argonaut Gold Mining Company, and the Zeila Mining Company, for reasons subsequently explained. The total tonnage of the county in 1908 was 422,155 tons, of which 421 tons of copper ore were shipped to the smelter, and 421,734 tons, or 99.90 per cent of the total tonnage, were milled. From this milling ore $1,214,776 in gold and $6,329 in silver was saved as gold bullion, an average of, respectively, $2.88 and $0.02 per ton. The total gold and silver obtained as bullion was valued at $1,221,105, an average value of $2.90 per ton. From this 421,734 tons of ore were obtained 8,934 tons of concentrates, which yielded $637,997 in gold, an average of $71.41 per ton, and $4,240 in silver, an average of 48 cents per ton, a total average of $71.89 per ton in gold and silver. The total extraction of gold from bullion and concentrates was $1,852,773, an average of $4.39 per ton, and the value of the silver was $10,569, an average of $0.03 per ton. The value of the total yield of both gold and silver from milling ore was therefore $1,863,342, an average value of $4.42 per ton. The yield of the placers of the county was 949.02 fine ounces of gold, valued at $19,618, and 808 ounces of silver, valued at $428.

At Amador City the Bunker Hill Consolidated mines are developed by a shaft 2,125 feet deep and are equipped with a 20-stamp mill, with concentrators. The present company began work in October, 1899, the mill began operations in February, 1904, and the property has been dividend paying since. The Keystone Consolidated mine at the same place is also a large producer, but was closed down part of the year. At Defender the Gold Ridge Mining Company is developing several claims, of which the Defender was the only productive one in 1908. The plant consists of a 10-stamp mill, with concentrators and a cyanide plant. During the year the mill only averaged fourteen days of work monthly. The Fremont Consolidated Mining Company, at Drytown, has 2 incline shafts, 1,400 and 1,550 feet deep, respectively, and 3½ miles of drifts. The Fremont shaft, which was burned out in November, 1907, was reopened and repaired in 1908, but this delay prevented the normal production during the first half of 1908. The reduction plant consists of a 40-stamp plate-amalgamation mill with 16 Frue vanners. The McNeeley mine, at Ione, furnished the smelter copper ore carrying both gold and silver; and at the same place the Newton Copper Company, which has an 80-ton water jacket furnace, made a small quantity of copper cement from old dumps by leaching. The mine has not been actively worked for several years. At Jackson the Argonaut Gold Mining Company, a large producer, has an incline shaft now 3,217 feet deep. During 1908 the 2,700-foot, the 2,800-foot, and 3,000-foot levels were opened up, but there was a large reduction of the mining force and of output, the 40-stamp mill not averaging over 20 stamps per twenty-four hours. The Kennedy Mining and Milling Company at the same place, the second largest gold producer in the State, completed its shaft to the 3,254-foot level in 1908 and opened up the 3,150-foot level. This mine is equipped with a 100-stamp plate-amalgamation mill, with concentrators, which was operated throughout the year. The Zeila Mining Company is another large producer at Jackson,

but repair work during the year somewhat restricted output. The Good Bye, at Oleta, and the A and B mine, at Plymouth, were small producers. The South Eureka Mining Company, at Sutter Creek, operated a 20-stamp plate-amalgamation mill, with concentrators. The incline shaft, 2,780 feet deep, was deepened 220 feet in 1908. There were some small productive placers at Lancha Plana, Oleta, and Volcano, and at the latter place the Garibaldi hydraulic mine made considerable output. The Penavett quartz mine, at Defender, was developed during 1908, but made no output, and the same was the case with the Bellwether, at Jackson. The Clinton Consolidated Mining Company did not run its 30-stamp mill during the year. The Jose Gulch mine was worked for six months, but its 10-stamp mill was not started up. As to hydraulic mines, the miners complain that the California Débris Commission is too exacting in the conditions imposed upon them to produce any gold by hydraulicking, and the industry has been virtually given up in the county. The Burlington Gold Mining Company, at Sutter Creek, worked its property for six months, but did not run its 6-stamp mill. Nothing was done at the mines and mills of the Wildman-Mahoney properties at Sutter Creek. The Central Eureka Mining Company made no product in 1908. The Telegraph Hill Gold Mining Company, at Volcano, has closed down permanently.

BUTTE COUNTY.

Owing to the extensive dredging operations at Oroville, Butte is the leading county of California in the production of gold, and the output has now, for the first time, passed in value the 3,000,000 mark, as is shown by the following table:

Mine production of Butte County, Cal., in 1907 and 1908.

Year.	Gold.		Silver.		Total.
	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		
1907	134,813.39	$2,786,840	13,587	$8,967	$2,795,807
1908	151,868.38	3,139,398	23,978	12,708	3,152,106
Increase	17,054.99	352,558	10,391	3,741	356,299

The mines which produced this large amount were 4 quartz, 1 hydraulic, 34 dredge, 11 drift, and 25 surface mines, a total of 75. No other county in the State made in 1908 a gold yield as high as $3,000,000 and it is many years since any county has done so.

The few producing quartz mines in Butte County are at Forbestown, Lumpkin, and Wyandotte. At the latter place the Wyandotte Mining Company has a 10-stamp mill and at Lumpkin the Triumph has a 2-stamp mill. The Carlisle mine at Forbestown has a 10-stamp mill with Johnston concentrators, and in 1908 a cyanide plant was added. About the close of the year increased activity was manifest at Forbestown, several of the old properties having been placed under bond and work being begun upon them. The yield in 1908 of the quartz mines of the county from 1,215 tons of ore was 651.66 fine

ounces of gold, valued at $13,471, and 1,204 fine ounces of silver, valued at $638, a total value of $14,109, all from 4 deep mines.

As to producing placer mines in the county, the Royal Drift Mining Company, at Berdan, was running a working tunnel in 1908 with the expectation of reaching the channel by July, 1909. A number of small placers were working at Brush Creek and vicinity. At Cherokee, the Cherokee Mining Company did hydraulic work for six months of the year. At Inskip, in addition to the small placers, the Sky High mine made a reasonably high product by both hydraulicking and drifting. The Fort Sumpter mine, at John Adams, is a drift property, as is also the Hintz mine, and the Snow mine, at Lovelock. The Cape Horn Mining Company, at Magalia, made a large output by drifting for four months of the year. There are several smaller drift mines at the same place and at Nimshew.

Oroville, the principal seat of mining operations of Butte County, is the most productive point of gold mining in the State, by reason of the large number of gold dredges at work there. These dredges produced in 1908, in gold, $3,043,151 out of $3,139,398 of gold for the whole county.

The following table shows the output of gold from the Oroville dredging field for several years past, with the increase or decrease:

Gold output of Oroville, Cal., dredging district, 1903–1908, with increase (+) or decrease (—), by years.

1903	$1,329,998	
1904	1,632,507	+$302,509
1905	2,261,887	+ 629,380
1906	2,768,782	+ 506,895
1907	2,697,092	— 71,690
1908	3,043,151	+ 346,059

The falling off in yield shown in 1907 was due to floods in the spring of that year, which wrecked a number of dredges and damaged several others. In 1908 the following dredging companies and dredges were in operation at Oroville: Butte Dredging Company, 1 dredge; El Oro Dredging Company, 2; Feather River Development Company, 6; Indiana Gold Dredging Company, 1; Leggett Gold Dredging Company, 1; Ophir Gold Dredging Company, 2; Oroville Dredging (Limited), 9; Oro Water Light and Power Company, 6; Pacific Gold Dredging Company, 4; Pennsylvania Dredging Company, 1; and the Viloro Syndicate (Limited), 1. This makes a total of 34 dredges at work in 1908, some of which, however, were not operated all the year. Some of these companies named have more dredges than those enumerated, the number given being only those which were in operation during 1908. Several new boats have been added at Oroville since the close of 1908. There is considerable placer mining in a small way, principally by Chinese, in the vicinity of Oroville. Around Stirling City, also, more or less placer mining is being carried on. This is true also at Yankee Hill and at other old placer-mining camps of Butte County.

As to nonproducing mines in the county, the Double Eagle Mining Company, at Berdan, was running a long bedrock tunnel to tap the channel, and this was to be completed in 1909. The Royal Drift Mining Company at the same place prepared for production in 1909. Bean & Corbiere, at Clipper Mills, did not operate their hydraulic mine in 1908, but were building a new dam in order to do so in 1909.

The Bear Canyon Mining Company, of Clipper Mills, is developing a quartz mine. Development work was also done on the Beik mine, at Forbestown, at the Phoenix mine, at Hurleton, and at the Happy Jack mine, at John Adams. At the Mammoth Channel Gold Mining Company's drift mine, at Magalia, development work was continued throughout the year.

CALAVERAS COUNTY.

Mine production of Calaveras County, Cal., in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		
1907	53,114.49	$1,097,974	82,454	$54,420	4,386,243	$877,249	$2,029,643
1908	66,685.47	1,378,511	118,353	62,727	4,473,030	590,440	2,031,678
Increase (+) or decrease (−)	+13,570.98	+280,537	+35,899	+8,307	+86,787	−286,809	+2,035

Calaveras County in 1908 materially increased its yield of metals over that of 1907, yet, owing to the low metal prices, the total increase in values in the county for the year was quite small. In tonnage the yield of ore in Calaveras County was 481,669 tons in 1908, an increase of 186,228 tons for the year. This ore yielded 54,999.09 fine ounces of gold, valued at $1,136,932, and 115,602 fine ounces of silver, valued at $61,269. The yield of copper was quite large from 2 mines only. Of gold derived from placers the yield for 1908 was 11,686.38 ounces, valued at $241,579. The placer silver was 2,751 ounces, valued at $1,458.

There were 427,470 tons of ore treated at gold and silver mills, being 88.75 per cent of the tonnage of the county. From this was obtained gold bullion valued at $717,252, or $1.67 per ton in gold, and $2,361 in silver—less than 1 cent per ton. The total saving in bullion was $719,613, or $1.68 per ton. From this amount of ore 7,672 tons of concentrates were produced, yielding $348,238 in gold and $1,850 in silver, a total of $350,088, an average of $45.39 per ton in gold and $0.24 per ton in silver, a total of $45.63 per ton. The milling ore then yielded a total of $1,065,490 in gold, the total average recovery per ton in gold being $2.49. Of silver the total average recovery was 1 cent per ton. The total gold and silver recovered was thus $2.50 per ton.

There were 59 producing mines in the county in 1908, of which 32 were deep, 2 being copper mines. The producing placers numbered 27, of which 3 were dredges, 12 drift, and 12 sluicing properties.

Of the producing deep mines in the county, the Angels Quartz Mining Company, at Angels, has a 40-stamp mill with concentrators. The mine is developed by a vertical shaft 850 feet deep. At the Bolitho Mining Company's property development was continued during the year with only a nominal output. The Etna King Mining Company, also at Angels, has a building for 20 stamps, and installed 10 in 1909, operated by electrical power. The 3-compartment vertical shaft is 235 feet deep. The principal development work was

done on the Zeigler Consolidated claim, 1,200 or 1,500 feet distant from the shafts of the Utica Mining Company. The Lightner Mining Company, a large producer at Angels, has a 60-stamp mill with concentrators and a 5-ton chlorination plant. The vertical shaft on the mine is 600 feet deep, and the winze 250 feet deep. The mine was operated for 10 months in 1908. The Utica Mining Company was worked through 2 shafts half a mile apart. The Cross shaft on the Stickle mine is 1,400 feet deep, vertical, and the incline shaft on the Gold Cliff is 1,100 feet. There is a 100-stamp mill with concentrators at the Cross shaft, and a 40-stamp mill with concentrators at the Gold Cliff mine. Shortage of water closed down work at the Cross shaft for four months and at the Gold Cliff for two months during 1908. At Campo Seco the Penn Chemical Works has a 200-ton smelter, pyritic blast furnace with 2 oil-burning reverberatories. This copper mine ran to its full capacity for nine months in 1908 and at about half capacity the remainder of the year. The Union Copper property, at Copperopolis, has a 100-ton copper smelter and a 400-ton concentrator. The plant was not operated in 1908, though some cement copper was leached out of the mine water. The Hanby quartz mine, at Fosteria, was a small producer. The Gwin mine is developed by a vertical shaft 2,532 feet deep, and a winze 273 feet deep. It is equipped with a 100-stamp mill and concentrators, operated by water power. The mine and mill were operated from January to August, and were then closed down. The Finnegan mine, at Irvine, was operated for six months of the year. It is developed by open cut and tunnel and has a 10-stamp mill with concentrators. The Melones Mining Company, at Melones, has a 100-stamp, plate-amalgamation mill with vanners and classifiers, and a cyanide plant. The main tunnel in this mine is 5,200 feet long on the 1,100-foot level, and there are several vertical shafts. This mine was closed in January and February, 1908, owing to a miners' strike. A number of small quartz mines are in operation at Mokelumne Hill, Murphy, North Branch, Railroad Flat, San Andreas, and Westpoint. At the Sheep Ranch mine some ore from old stopes in the upper levels was milled in the 20-stamp mill, but the mill and the cyanide plant were only operated two months in 1908. The mine has been virtually closed down since November, 1907. The Lightning Rod or Thompson mine, at Westpoint, is equipped with a 5-stamp mill, but very little work was done on the property in 1908. Some placer mines were worked at Camanche, Campo Seco, Douglas Flat, Felix, Irvine, Mokelumne Hill, Murphy, Melones, North Branch, Railroad Flat, and San Andreas. The Calaveras Dredging Company had a dredge in operation at Jenny Lind, as had the Isabella Gold Dredging Company. The Mokelumne Mining Company operated a dredge at Wallace for six months in 1908. The larger part of the placer production came from the 3 dredges. The drift mines at Mokelumne Hill, among which are the Boston, Duryea, and North Star, yielded nearly $16,000. Small drift mines are also operating at Railroad Flat.

Among the nonproducing operators of Calaveras County were the Ingomar Consolidated Gold Mining Company, at Campo Seco, the Demarest Mining Company, at Fourth Crossing, and the Peyton Chemical Company owning the Napoleon copper mine at Milton. The Green Mountain mine, at Mokelumne Hill, produced no gold, but

furnished $10,000 worth of quartz crystals in 1908 to jewelers. The Consolidated Wide Awake Mining Company, at Mokelumne Hill, the Shenandoah Mining and Development Company, at Mountain Ranch, and the Clary Gold Mining Company, at Murphy, did not produce. The Swiss mine (formerly Live Oak), at Railroad Flat, and the Duchess mine, at Vallecito, were idle. The Farrington Gold Mining Company, at Westpoint, is equipped with a 20-stamp waterpower mill and concentrators, but was also idle. Most of the properties mentioned above are equipped with 5-stamp or 10-stamp mills.

ELDORADO COUNTY.

El Dorado, which is one of the five Mother Lode counties of California, produced in 1908 gold valued at $342,033 and silver valued at $5,504, a total of $347,537. This was an increase of $26,059 in total value, as compared with the figures of 1907. The ore treated from the deep mines amounted to 10,521 tons, which yielded 9,925.53 fine ounces of gold, valued at $205,179, and 7,721 ounces of silver, valued at $4,092, a total of $209,271. The placer mines of the county yielded for the year $136,854 in gold and $1,412 in silver, a total of $138,266.

In Eldorado County all the tonnage was sent to gold and silver mills. The gold saved on the plates was $177,345, an average of $16.86 per ton, and the silver was $3,889, or $0.37 per ton, the total saved on plates being valued at $181,234, an average value of $17.23 per ton. There were 225 tons of concentrates derived from the milling ore, which yielded $27,834 in gold and $203 in silver, a total of $28,037 in gold and silver, or $123.71 per ton in gold and $0.90 in silver, an average of $124.61 per ton in both gold and silver. The 10,521 tons milled yielded therefore, on the plates and from the concentrates, a total of $205,179, in gold, an average per ton of $19.50. The silver saved on the plates and from the concentrates was valued at $4,092, or $0.39 per ton. The total gold and silver from the ore was therefore $209,271, and the average total yield was $19.89 per ton. This average is very high, but is in part accounted for by the fact that from a certain mine in the county one ton of ore from a pocket was exceptionally rich.

Reports were received from 64 producing mines, of which 30 were deep mines and 34 were placers, the latter consisting of 3 hydraulic, 12 drift, and 19 sluicing mines.

At Georgetown is the Beatty group, where the small seams of rich quartz yield considerable gold. The Everson mine at Georgetown is quite a large producer, and at the same place are numbers of small operators whose combined yield is important. At Greenwood are the McGrubb, Modoc, Oakland Consolidated, and other small producing properties.

The Golden Spike mine, at Grizzly Flat, has a 5-stamp mill and is developed by 3 tunnels. Crosscutting was carried on during 1908 while the mine was under bond to the El Dorado Exploration Company. The Adams Gulch mine, at Nashville, and the Heald's and Lone Star made a small output. At Omo Ranch the Berkeley and Hornet, and the Richmond, Syracuse, and Potosi, and the Stillwagon Mining and Milling Company were in operation. The Independence mine, at Placerville, made a rich yield from a pocket in 1908 from 1 ton of ore. The Sherman Mining and Milling Company, at

Placerville, has a 10-stamp, plate-amalgamation mill with concentrators, erected in 1908, which was in operation only a portion of the year. The mine is opened by a 700-foot incline shaft. The Alveroro Mines Company, at Smithflat, has 2 barrel mills of the Dodge type, but they were not operated in 1908, and the mine only made a nominal output from specimen ore.

Of placer mines in the county several small properties were sluicing at Garden Valley. At Georgetown the operators of the Tip Top Hill mine and the Two Channel Mining Company were drifting. The placers, at Green Valley, are small sluicing properties. The Rocky Bar mine at Grizzly Flat is worked by sluicing in an open cut. The Sunshine Mining and Development Company at the same place made quite a large output by drifting in the gravel of an ancient river bed. At Indian Diggings one drift mine and a number of small placers were producers. There are several small drift mines at Fairplay. At Omo Ranch are 2 drift mines and 2 sluicing properties, and the placers at Pino Grande are small ones. At Placerville the United Mining Company's claim is worked by the hydraulic method, and some quartz ledges, carrying gold, are found in the deposit. The Excelsior and Pacific mines, owned by the El Dorado Water and Deep Gravel Mining Company, at the same place, are equipped with a 10-stamp mill for crushing the gravel which is drifted out. There is a tunnel 5,476 feet long, and in 1908 1,427 feet of drifts and 175 feet of raises were driven. The placer production from the vicinity of Placerville amounted to $96,571; a large part of this came from small and Chinese mines.

The well-known Union mine at El Dorado was worked in the latter part of 1908, but the 20-stamp mill was not operated until in January, 1909. The Capitola mine, near El Dorado, was also opened about the close of 1908. The Good Luck Gold Mining Company, at Diamond Springs, has a 5-stamp mill, but it was not run in 1908. The Noonday copper mine, at El Dorado, owned by the Peyton Chemical Company, which was productive in 1907, was not worked in 1908.

The following notes summarize other nonproducers in 1908: The Blue Bird mine at Georgetown is equipped with a 10-stamp mill. The Alpine mine, owned by the Lucero Mining Company at Georgetown, was being developed through a 400-foot shaft. The Sierran Mining Company, at Grizzly Flat, is equipped with a 10-stamp mill. The Golden Gate Mining Company, at El Dorado, has a 20-stamp mill, and the Baltic group has a 10-stamp mill. The operators of the Boston (formerly the Julia) mine at Pilot Hill put up a 5-stamp mill with concentrators in 1908. The Red Ravine mine, at Shingle, and the Sunrise mine at Slatington, are equipped with 10-stamp mills.

HUMBOLDT COUNTY.

Humboldt County produced in 1908 gold valued at $33,066 and silver valued at $325, a total value of $33,391, which was less by $7,128 than the output in 1907. Most of the mines are placers, 21 operators reporting production. There are only 2 lode properties, both at Orleans, with a nominal output. With the exception of 2 sluicing properties and 1 drift mine, all the placers in the county are worked by the hydraulic process. At China Flat are the mines of the Clover Flat Mining Company, the Red Porphyry, and several smaller mines. A nominal production was reported from Hoopa. At

Orleans are the Croton Bar, the mines of the California Mining and Dredging Syndicate, Halverson Bar, Ferris, Nelson, Pearch, Little Klondike, Rocky Point, Rough and Ready, Salstrom, and several smaller properties. The Cavanaugh and Weitchpec mines are both at Weitchpec. Most of these hydraulic mines had a short season, and for this reason the output of the county fell off in 1908.

INYO COUNTY.

The value of the metals produced in Inyo County in 1908 was $386,920, or $130,734 more than in 1907. The gold output in 1908 was 14,941.73 fine ounces, valued at $308,873; the silver, 58,302 ounces, valued at $30,900; the copper, 3,690 pounds, valued at $487; and the lead, 1,110,952 pounds, valued at $46,660, the total value being $386,920. Although the county increased its gold yield in 1908 by $251,632, there was a decrease of $13,540 in silver, of $2,630 in copper, and of $90,949 in lead. Moreover, zinc to the value of $13,779 was produced in 1907, but there was no yield from this source in 1908. There were 25 deep producing mines reporting from the county in 1908, of which 18 were gold properties, 5 were lead mines, and 2 were silver-lead properties. The deep mines produced 39,440 tons of ore. No placers were worked in the county in 1908.

Among the deep mines producing in the county, the Arondo Gold Mining Company crushes its ore with Cornish rolls and then cyanides it. The operators of the Cecil R., at Ballarat, put in rolls and cyanide tanks in 1908. The mine was worked throughout the year, but the mill was only operated for a short time. The Golden Rod Mining Company, also at Ballarat, has a 5-stamp mill and a cyanide plant. The World Beater mine of the Pleasant Canyon Mining Company is equipped with a 10-stamp mill and a 50-ton cyanide plant. The J. P. Fitting Company, at Big Pine, shipped lead-silver ore. The ore from the Lease & Waterman mine carries lead, silver, and some gold. At Big Pine are a number of properties, of which the Buckeye, a large low-grade mine, was expected to produce in 1909. The Ubehebe Mining Company made a small output of silver-lead ore. The New Coso Mining Company, at Darwin, shipped a considerable quantity of silver-lead ore. The John Cress mine, at Darwin, produced high-grade gold ore in 1908. The Four Metals Mining Company, at Keeler, has a 150-ton smelter and has been doing extensive development work; it has also been smelting slag carrying gold, silver, and lead from the old Cerro Gordo mine. The Graves Hallett Mining Company and the Mount Whitney, at Lone Pine, were both small producers, as was the Cook, at Skidoo. The Skidoo Mines Company, at Skidoo, is a new property with a large production. It has a 15-stamp mill with concentrators and a cyanide plant, but only 10 stamps were in operation from July 1 to December 31, 1908. The mine is developed by a vertical shaft 330 feet deep and a 1,600-foot tunnel. During the year 1,500 feet of development work was done. At Tecopa the principal producer was the Tecopa Consolidated Mining Company; the ore carries gold, silver, copper, and lead. The Keane Wonder Mining Company was the largest producer in the county; its 20-stamp mill was not operated the whole year. There are no productive placers in the county.

There were many nonproducing mines in Inyo County on which more or less development work was being done. Among them are properties

of the Cashier Mining Company, at Ballarat, the Iron Cap mine, the Iowa mine, the property of the Buckeye Mining Company, and the McPherson mine at Big Pine.

The Black Canyon Mining Company continued developing its property. The Inyo Mines Syndicate, at Bishop, extracted ore in 1908, but no shipments were made owing to the low price of silver. The property of the North Inyo Consolidated Mines Company, at Bishop, is still in process of development. The mines in the Bishop district were developed during the year on a small scale, although some extensive ore bodies were reported. The large veins with gossan capping which lie between a limestone and a schist, varying from 12 to 30 feet in width, carry values in gold, silver, and copper. The Inyo Coso Mining Company, of Darwin, has a small crusher with concentrator, upon which work began in November, 1908. From Greenwater there was no output in 1908. The Brown Monster mine, at Independence, was idle during the year. The Reward Gold Mining Company at the same place has a 20-stamp, plate-amalgamation mill with concentrators, but no ore was milled. The Inyo Copper Mines and Smelting Company, at Keeler, has been doing considerable development work in shafts and tunnels. The Mono Mining and Milling Company, at Laws, is equipped with Cornish rolls and Huntington mills and expected to be productive in 1909. The Southern Belle Mining Company at the same place has a 10-stamp, plate-amalgamation mill. Considerable ore has been reported blocked out, but none was milled. The mine is developed by 8 shafts and 5 tunnels. In Lee district no production was made; there are no reduction works close at hand, and no cheap means of transportation for ores. The majority of the properties in the camp are idle, awaiting water, which it is expected will be piped in during 1909.

KERN COUNTY.

Mine production in Kern County, Cal., in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		
1907	42,511.85	$878,798	130,353	$86,033	.....	.....	$964,831
1908	40,010.33	827,087	182,170	96,550	144	$19	923,656
Increase (+) or decrease (−)	−2,501.52	−51,711	+51,817	+10,517	+144	+19	−41,175

While the silver output increased in Kern County in 1908 as compared with that of 1907, the gold yield fell off sufficiently to cause a decrease of $41,175 in value for the county for 1908. There were 259,968 tons of ore worked in the county during the year, which yielded 38,924.65 fine ounces of gold, valued at $804,644, and 181,657 fine ounces of silver, valued at $96,278, with a nominal quantity of copper. The placers yielded 1,085.68 ounces of gold, valued at $22,443, and 513 ounces of silver, valued at $272. The 4 placers are all sluicing mines, and there were 40 productive deep mines.

The Amalie quartz mine, at Amalie, has a Huntington mill which was run only two months in 1908. The White Star, at Bodfish, has a

small 2-stamp mill which was operated for a portion of the year. At Isabella the deep mines were all small producers. In Keyes district there were several small producers. At Mohave the Queen Esther Mining and Milling Company had a large output. The mill has dry crushing rolls and a cyanide plant with a daily capacity of 130 tons. The precipitates are shipped to the smelter. A good deal of the output of this mine was from old tailings. The San Antonio mine, equipped with Cornish rolls, had a small output. At Piute a 3-stamp mill was erected on the Bowman mine. The Castle Rock mine, at Piute, has a steam arastre. The Jeanette at the same place was a small producer. The Kern County Consolidated Mining Company, one of the larger producers, is equipped with a 3-stamp Hendy mill, and has 2 tunnels, respectively 800 and 1,500 feet long, and a 300-foot shaft. The Minnehaha Mining and Milling Company, at Paris, has a 3-stamp mill with concentrators and a tunnel 1,800 feet long, which was extended 400 feet in 1908.

The Randsburg district, including all the mines near Randsburg, and Johannesburg, had a prosperous year. Their total production was $656,560 in gold and $5,321 in silver. The Butte Lode Mining Company milled its ore at custom mills. There are several shafts on the property, the deepest of which is 523 feet. The "G. B." mine in this district was also productive. The Gold Bank mine was worked under lease and the ore was treated in a 2-stamp mill with a cyanide plant, owned by the lessees. The Sydney Annex was quite a large producer. The Napoleon Consolidated Mining Company operated the Napoleon, Santa Ana, and Yucca Tree claims spasmodically through lessees during 1908. The Sunshine mine is equipped with a 3-stamp mill and small cyanide plant and had a considerable output of rich ore. The Gold Coin and Stanford mines, owned by the Stanford Mining Company, has a 10-stamp, plate-amalgamation mill which was operated continuously during 1908. The Winnie was a small producer. The Yellow Aster Mining and Milling Company, the largest producer in the southern part of California and one of the largest in the State, has one 100-stamp, plate-amalgamation mill and one 30-stamp mill. The mine is developed by shafts and tunnels, and the developments are extensive. Two shafts were sunk during 1908. The Rose Rock, White River, and Reed mines, at Tehachapi, were small producers in 1908. The placers of the county are at Goler, Red Rock, Isabella, Randsburg, and Ricardo, and are both dry-washing and sluicing mines.

There are many mines which reported development work. The Zenda Mining and Milling Company, at Amalie, did considerable development and construction work during the year. The Greenback Copper Company, in Woody district, has considerable ore on hand ready for shipment. The Little Angel, at Havilah, has a 10-stamp mill and cyanide plant, but no production was made during the year. The Piute Consolidated Mining and Investment Company, at Havilah, continued development. The Golden, at Caliente, has finished construction of a 20-ton roller mill and concentrating table. The Exposed Treasure Mining Company, at Mohave, has a 25-stamp mill with concentrators and cyanide plant, but was closed down pending deeper development. The "B. C." Mining and Milling Company, at Rosemond, has a 10-stamp mill and cyanide plant, but it was not operated in 1908, though mine development was continued.

MARIPOSA COUNTY.

Mariposa, one of the Mother Lode counties of California, had in 1908 a production valued at $449,446, which was $38,201 more than the yield of 1907. The output of gold in 1908 was 21,278.33 fine ounces, valued at $439,862; of silver, 8,928 ounces, valued at $4,732; and of copper, 36,757 pounds valued at $4,852. The placer gold amounted to 144.21 ounces, valued at $2,981, and the placer silver was 43 ounces, valued at $23. The quartz mines treated 53,724 tons of ore, and there were 248 tons shipped to the smelter, the shipment yielding $200 in gold, $192 in silver, and 36,759 pounds of copper. The copper in the ore averaged 7.41 per cent. Of the total tonnage 99.54 per cent, or 53,724 tons, was siliceous ore, which yielded $381,296 in gold in bullion, or $7.10 per ton, and $3,843 silver, or $0.07 per ton; the total gold and silver in bullion was $385,139, or an average of $7.17 per ton. From this ore were derived 691 tons of concentrates, which yielded $55,385 in gold and $674 in silver, a total of $56,059. The concentrates therefore yielded $80.15 per ton in gold and 98 cents per ton in silver, an average yield of $81.13 per ton in both gold and silver. The siliceous ore yielded on the plates and from the concentrates a total of $436,681 in gold, or an average of $8.13 per ton, and a total of $4,517 in silver, or an average of $0.08 per ton. The total yield of both gold and silver from this ore was $441,198, or an average total value of the ore treated of $8.21 per ton.

There were 25 deep mines worked in the county in 1908, of which 23 were gold mines and 2 were copper mines. There were also 2 placer properties.

Not more than half a dozen deep mines in Mariposa County made a large production in 1908. The Green Mountain copper mine, at Ben Hur, produced only a small quantity of copper ore. The Jumper, the Mahoney, the Specimen, and the Felix mines, at Bear Valley, made a nominal output only. Several properties at Coulterville were small producers, and a considerable sum was derived from "pocket" mining in that section of the county. The Ruth Pierce Mining Company, of Hornitos, made an important production from the Grimshew mine. The Mount Gaines Consolidated Mining Company, at Hornitos, operated the most productive mine in the county. It is equipped with a 20-stamp, plate-amalgamation mill, concentrators, and a complete electrical power plant, which was added during 1908. The mine is worked through an incline shaft 1,036 feet deep, and a great deal of shaft and drift work was done during the year. Several small producers reported from Kinsley. The Pocahontas Copper Mining Company, at Lewis, took out ore during development work, which was shipped to smelters. The various mines of the Mariposa Commercial and Mining Company on the Fremont grant made a considerable production, both from company work on their own properties and from leases. The Mountain Bell mine, at Mount Bullion, made only a small output. The Farmers Hope, at Whitlock, has a 5-stamp mill and concentrators, and made a small product. The Sunshine and Potato Hill mines produced gold chiefly from pockets. The few placers of the county are at Kinsley and on the Mariposa (or Fremont) grant. Their combined output was not large.

Among nonproducing mines the Cavin Mining and Milling Company, at Ben Hur, did development work. The Hite mine, at Jerseydale, has a 20-stamp, plate-amalgamation mill, to which a cyanide plant was added during 1908. Considerable prospecting work was done. The Omparisa Gold Mining Company, at Kinsley, has a 10-stamp mill, and only development work was done. The Austin group, at Whitlock, is equipped with a 10-stamp mill.

MONO COUNTY.

In 1908 Mono County produced metal valued at $440,182, as compared with a total value of $413,768 in 1907. The quartz gold, derived from 39,190 tons of ore, was 20,007.13 fine ounces, valued at $413,584; and the placer gold was 17.51 ounces, valued at $362, the total gold being 20,024.64 fine ounces, valued at $413,946. The total silver from deep mines was 49,306 fine ounces, valued at $26,132, and the placer silver was 4 ounces, valued at $2, the total silver being 49,310 ounces, valued at $26,134. There was produced also 2,429 pounds of lead valued at $102. There is only one surface mine producing in the county, and there are 10 deep producing mines.

The productive deep and placer mines in Mono County are few in number, and only a few of these make any large output. Bodie and Masonic are the most important camps. At Berlin is only one small productive deep mine. The New Bodie mine, at Bodie, produced considerable gold. At the same place is the most important producer in the county, the Standard Consolidated Mining Company, whose 20-stamp mill was in operation, with extensive cyanide plants. The mine was also in active operation throughout the year. A number of other properties were being developed at Bodie. The Crystal Lake Gold Mining Company, at Lundy, has a 20-stamp mill with concentrators, and a small cyanide plant has been added. The reduction plant was only operated for one month in 1908, though a great deal of development work was done in the mine. The mine is opened by a tunnel 4,000 feet in length. The Pittsburg Liberty Mining and Milling Company, at Masonic, has a 10-stamp mill which was run for ten months in 1908. The output of the property is important. The Casa Diablo Mining Company, in Sherwin district, has a 10-stamp, plate-amalgamation mill with concentrators, but this was only run in an experimental way in 1908. The mine is developed by a tunnel 610 feet long. There are a few placer mines in the county, all at Dogtown Creek, near Bridgeport.

The Mineral mine, near Bridgeport, made no output for the year, but was being developed. At the Sweetwater Consolidated Mining Company's property the 10-stamp mill was being remodeled. The Dauntless mine, at Lundy, has a water-power Brown rotary grinder mill, but no ore was crushed, though considerable development work was done.

NEVADA COUNTY.

Mine production of Nevada County, Cal., in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		
1907	104,590.76	$2,162,083	25,522	$17,505	22,111	$4,422	$2,184,010
1908	111,163.96	2,297,963	41,347	21,914			2,319,877
Increase (+) or decrease (−)	+6,573.20	+135,880	+15,825	+4,409	−22,111	−4,422	+135,867

In Nevada County the value of the total metallic output for 1908 showed an increase in value of $135,867 over that of 1907. The tonnage treated in 1908 was 220,067 tons as compared with 227,617 tons in 1907, a decrease of 7,550 tons in 1908. There were 48 productive mines in the county in 1908, of which 35 were deep mines and 13 were placers. Of these latter, 3 were hydraulic, 3 drift, and 7 surface mines.. The placer gold aggregated in value $88,050, of which $45,890 came from hydraulic mines, $28,030 from drift mines, and $14,130 from sluicing properties. The deep mines produced 220,067 tons of ore, which yielded 106,904.54 fine ounces of gold, valued at $2,209,913, and 40,539 ounces of silver, valued at $21,486, a total of $2,231,399.

The milling practices in Nevada County, and especially in Grass Valley district, are typical of the California system, and are carried out on a large scale. The practices in other counties vary little from those of Nevada County, though in all of them such close work is not always done and the values of the ore treated are different in different counties.

The total siliceous ore treated at gold and silver mills in the county in 1908 amounted to 220,064 tons. The value of gold saved as bullion was $1,984,420, or $9.02 per ton, and the value of silver was $12,275, or 5 cents per ton. The total value of gold and silver recovered as bullion was $1,996,695, or an average of $9.07 per ton.

From the ore milled there were obtained 4,424 tons of concentrates, which yielded $225,359 in gold, or an average of $50.94 per ton, and $9,208 in silver, or an average of $2.08 per ton. The total value of concentrates was $234,567 in gold and silver, or an average value of $53.02 per ton.

From the tonnage named was obtained from bullion and concentrates gold valued at $2,209,779, or an average value of $10.04 gold per ton. The total saving of silver amounted to $21,483, or an average of 10 cents per ton.

The total gold and silver obtained as bullion and from concentrates was $2,231,262, the average value of all the ore milled being $10.14 per ton in gold and silver. In 1907 the average value of all ores milled in the county, in gold and silver, was $9.06 per ton, and in 1906 it was $8.74 per ton.

From these figures it will be seen that the average value per ton of the ore milled is gradually increasing.

The principal quartz-mining district of Nevada County, and of California, is that of Grass Valley, which includes the mines of both Grass Valley and Nevada City. The following table shows the production of the quartz mines of Grass Valley district in 1907 and 1908:

Production of Grass Valley and Nevada City quartz mines, Nevada County, Cal., 1907 and 1908.

Year.	Grass Valley mines.			Nevada City mines.			Grand total.
	Gold.	Silver.	Total.	Gold.	Silver.	Total.	
1907	$1,744,752	$11,200	$1,755,952	$219,514	$5,379	$224,893	$1,980,845
1908	1,869,176	11,953	1,881,129	192,037	8,552	200,589	2,081,718
Increase (+) or decrease (−)	+124,424	+753	+125,177	−27,477	+3,173	−24,304	+100,873

It will be noted from this table that the Grass Valley mines increased their output for 1908 over 1907 by $125,177, and that the Nevada City mines decreased their yield in the same period $24,304. The increase of yield from the mines of the entire district was $100,873. The other quartz mines of the district combined showed some reduction in yield, but the North Star Company increased its output in 1908 over that of 1907 by $150,904, and was the only gold-quartz property in the State which made a yield of over $1,000,000 in 1908.

The Grass Valley quartz mines produced 73 per cent of the tonnage of the whole county, and the mines of Nevada City 17 per cent, the district of Grass Valley having produced, therefore, 90 per cent of all the ores milled in Nevada County in 1908. The Grass Valley deep mines produced $1,869,176, or 84.6 per cent of the quartz gold obtained in Nevada County in 1908, and 55.6 of the quartz silver, or 84.3 per cent of the total values derived from quartz ores. The Nevada City deep mines produced $192,037, or 8.7 per cent of the quartz gold of the county, and 39.8 per cent of the quartz silver. This was 9 per cent of the total values derived from quartz ores of the county.

Grass Valley district (including the Grass Valley and the Nevada City mines) produced 93.3 per cent of the quartz gold of the county in 1908, and 95.4 per cent of the quartz silver. Therefore, 93.3 of all the gold and silver value derived from the quartz mining operations in Nevada County in 1908, came from the quartz mines of Grass Valley district.

The most productive quartz-gold property in the State is that of the North Star Mines Company at Grass Valley, which is developed by an incline shaft 5,400 feet long and a vertical shaft 1,600 feet deep, cutting the incline at 4,000 feet. The property is equipped with two 40-stamp, plate-amalgamation mills, with concentrators, and 2 extensive cyanide plants. A description of the operations at this mine was given in the report of last year. The Ben Franklin Mining Company, at the same place, made a small output in 1908. The Brunswick Consolidated Mining Company has a 20-stamp, plate-amalgamation mill, with concentrators, and the property is developed by a 1,250-foot incline shaft. The Cassidy Consolidated Mining Company sent its ore to a custom mill for reduction. The Central

Consolidated Mining Company has a 20-stamp mill, with concentrators, and a slime plant. The mill was operated only for fifty days in 1908, owing to scarcity of water, but development work was continued throughout the year. The Conlin Mining Company was also a producer. The Empire mines have a 40-stamp mill. The Idaho-Maryland Development Company has a 20-stamp, plate-amalgamation mill, with concentrators. This is an old mine reopened and again made productive after considerable development work had been done and the 4-compartment shaft retimbered to the 1,000-foot level. Since the close of 1908 very important ore bodies have been reported in the mine. The Kenosha Mining Company has a 5-stamp mill, and made a small output; development work was continued during the entire year. The Bryden was also a small producer. The Pennsylvania Mining Company made an important output. The Sultana Mining Company has a 20-stamp mill; there are several claims included in this property. The Union Hill Consolidated Mining Company has a 10-stamp mill, which treated ore taken out during development work; without stoping, about $31,000 was obtained, and a larger output is expected in 1909.

The Jenny Lind Mining Company and the Posey Canyon Gold Mining Company operated producing drift mines adjacent to Grass Valley.

At Nevada City, in the Grass Valley district, the Bellefontaine Mining Company is a deep-mine producer. The mine of the Champion Mines Company is the most extensive property at that place, and has been of late worked largely by lessees, as well as on company account. The Murchie Gold Mines Consolidated Company has a 20-stamp, plate-amalgamation mill, with concentrators, and the mine is developed by a vertical shaft 1,150 feet deep. There are a number of other quartz mines near Nevada City which were productive in a small way.

Among other producing deep mines of the county outside of Grass Valley and Nevada City, the Bed Rock and Kennebec at French Corral may be noted. The Gaston Gold Mining Company, at Gaston, has a 40-stamp plate-amalgamation mill, with concentrators and canvas plant. Development in the mine began in July, 1908, and the milling of ore was begun in August, 1908. The Birchville Mining Company, at Graniteville, built a 10-stamp mill in 1908, with concentrators, and operated it a short time. The Dillon mine, with a 4-stamp mill, at Graniteville, made a small output. The Consolidated St. Gothard Mining Company, at North Columbia, made a good output for the year. The Ethel, Olson, and Red Robin, at Washington, were all small producers; the last named has a 4-stamp mill. The Yuba Consolidated Gold Mining Company is doing considerable development work on its properties; it has a 20-stamp mill on the Yuba mine, 10 stamps on the Gray Eagle, and 30 stamps on the Eagle Bird. Among the placers, the Esperance Drift Mining Company worked its gravel property three months in 1908 by the hydraulic process and five months by drifting. The Liberty Hill mine, at Lowell Hill, was worked by the hydraulic process for a time.

Among nonproducers in 1908, the South Yuba Mining Company, at French Corral, has a 10-stamp mill and is running a new tunnel. The Erie Consolidated Mining Company, at Graniteville, has a 30-stamp mill, and the New York Grass Valley Mining Company has a 12-stamp mill. The Niagara, at Grass Valley, has a 15-stamp mill,

but the mine was only worked three months during 1908. The Springhill Mining Company drifted continuously throughout the year, but made no output. The Sunflower Gold Mining Company did not run its 5-stamp mill, but performed considerable development work and built a ditch, with dams, flumes, etc., for water power. The California-Montana Mining Company, at Nevada City, carried on exploration work for nine months. The 5-stamp mill of the Chapman mine was idle, though considerable sinking and drifting was done on the mine. The Pittsburg mine was being reopened after being idle four years. At the Sierra Queen Gold Mining Company's property the 10-stamp mill was idle. The 10-stamp mill of the Grizzly Ridge, at North Columbia, was idle, but a lower tunnel was being advanced. The Black Bear Mining Company, at Rough and Ready, is putting in modern machinery, and a 10-stamp mill is being erected at the Ironclad mine at the same place. The Sycamore California Mining Company, at Washington, did not run its 10-stamp mill, nor did the Washington Mining Company at the same place work its 20-stamp mill.

PLACER COUNTY.

In 1908 Placer County produced metals valued at $360,290, as compared with $489,687 in 1907. The total gold yield in 1908 was 17,322.90 fine ounces, valued at $358,096, and the silver was 4,139 ounces, valued at $2,194, the total value of gold and silver being $360,290. The deep mines produced from 16,554 tons of siliceous ore 4,404.79 fine ounces of gold, valued at $91,055, and 1,162 ounces of silver, valued at $616. The placer-mine yield was 12,918.11 fine ounces of gold, valued at $267,041, and 2,977 ounces of silver, valued at $1,578. The output from gravel mines is seen to be much larger than that from quartz mines. There were 43 productive placers in the county, of which 6 are hydraulic, 12 drift, and 25 sluicing mines, and there were 13 productive deep mines. In the county the hydraulic mines yielded $44,155, the drift mines $180,504, and the surface mines $42,382.

As stated, there are only 13 deep productive mines in Placer County, and very few of these make any large output. A small yield was made by the Jubilee mine at Auburn, and also by the Malmberg, which is equipped with a 5-stamp mill. The Alameda mine, at Colfax, produced from decomposed quartz by sluicing. The Zelma Belle at the same place ran on a small scale. The Bellevue, at Ophir, was also productive. The Rawhide Gold Quartz Mining Company, at Towle, was the largest producer from quartz mines; its mine is equipped with a 10-stamp mill and concentrators and is developed by 2,800 feet of tunnels, 4 in number. The Southern Cross, at the same place, was a small producer, as was the Herman mine, at Westville, owned by the Northern California Mines Company; the mine had a 10-stamp mill in 1908.

Among the gravel mines the drift properties are the most important, as very few hydraulic mines are now in operation in the county. The Brown's Bar Consolidated Mining Company, near Auburn, operates both by hydraulic and sluicing systems. The Gaylord & Greenwood mine is run by both drift and hydraulic methods. A great deal of placer mining is done near Auburn by small operators, mainly Chinese. At Blue Canyon the Blue Canyon

Mining and Development Company has been sluicing in a small way. The Haub mine, at the same place, is a drift mine. The Hidden Treasure Mining Company, at Bullion, on the Forest Hill divide, operates the largest drift mine in the State, but was in poor gravel during 1908. The Annie Laurie, Delmar, Old Miner, and a few others near Colfax made a small output by sluicing. The Southern Cross, at Dutch Flat, made its yield by hydraulicking, as did the South Yuba Mining and Development Company, at Emigrant Gap. The Lehigh Canyon Company, at Forest Hill, sluiced old tailings only, as did the Indian Hill, at Gold Run. There are a number of small sluicing properties in the vicinity of Gold Run, and the United Water and Power Company worked its claim both by hydraulicking and drifting. The Big Dipper Mining Company, at Iowa Hill, is a drift property now owned by the McGeachin Gold Mining Company; it made the largest output in the county. Several small mines near Lincoln and at Loomis were in operation. The hydraulic mine of the Big Gun Mining Company, at Michigan Bluff, was operated by lessees. At the same place the Bigelow and the Bird mines showed small yields from drifting, and the Home Ticket made a large output. The Morning Star Drift Mines Company (Limited) finished its main tunnel in June, 1908, and began producing. This property, like that of the Pacific Consolidated Company at the same place, is a drift mine. The Park & Brown is a hydraulic mine. The Placer Gravel Gold Mining Company operated continuously during 1908 by drifting, at Michigan Bluff. Placer mining in a small way was carried on near Newcastle, Towle, Weimer, and Westville. At Yankee Jims a little placer and drift mining is being done.

There is quite a large number of unproductive mines in Placer County, on some of which, however, considerable work was done. At the Elite Consolidated mine, at Blue Canyon, the bedrock tunnel was continued. At the Derby mine, at Yankee Jims, similar work was done. The Lost Emigrant mine, at Donner, was not operated. The Polar Star hydraulic mine, at Dutch Flat, has been closed by injunction. At the Central mine, at Forest Hill, a new tunnel was started in 1908. The operators of the Peckham Hill mine, at Forest Hill, were putting up machinery in order to begin operations. Development work was commenced in the Barton drift mine, at Loomis, but there was no output. At the Haney Consolidated mine, at Michigan Bluff, work continued on the bedrock tunnel to tap the channel. The St. Lawrence, at Newcastle, was idle during the year. The Kittler Consolidated Mining Company, at Ophir, only commenced operations in July, 1908, and a shaft was being sunk. The Central Gold Mining Company, at Towle, has a 10-stamp water-power mill, and a tunnel is being driven on the vein. The Dairy Farm, at Van Trent, has a roller mill, a tube mill, and a cyanide plant. The Barton mine, at Westville, has a 10-stamp and a 30-stamp mill, but there was no production. At the Glen Consolidated mine, at Westville, the operators have been driving a bedrock tunnel for two years.

PLUMAS COUNTY.

The total yield from the mines in Plumas County in 1908 was valued at $258,297, as compared with $220,303 in 1907. The total gold in 1908 was 12,322.90 fine ounces, valued at $254,737, and the total silver 6,717 ounces, valued at $3,560. The 29,537 tons of sili-

ceous ore treated at the mills yielded 7,339.65 fine ounces of gold, valued at $151,724, and 1,494 ounces of silver, valued at $792. The placer mines, including all kinds, yielded 4,983.25 ounces of gold, valued at $103,013, and 5,223 ounces of silver, valued at $2,768. There were only 6 productive quartz mines in the county, while there were 45 placers. Of these latter 11 are hydraulic, 6 drift, and 28 surface mines. There were 78 mines reported as idle in 1908. The hydraulic mines of the county yielded $26,060, the drift mines $7,637, and the surface mines $69,316 in gold.

The most important quartz mine is that of the Jamieson Mining Company, at Johnsville, which has a 20-stamp mill but no tables, as the concentrate was of too low grade to pay. Both mine and plant were operated eight months of the year, there being a failure of water for power for four months. This mine is drained by a tunnel extending from the bottom of the shaft. The ore is hoisted through the shaft. There are 4 drift tunnels on the ledges, aggregating 6,473 feet, and 1 crosscut tunnel of 1,500 feet. Considerable drifting was done in 1908.

The Johnson-Graham Mining Company, operating the Plumas Eureka mine, at Johnsville, has a 20-stamp plate-amalgamation mill. The old tunnel was reopened during 1908. The Bluff City mine, at Quincy, has a 10-stamp mill and made a small output, and the Crown Point Mining Company (Limited) also produced. The Seneca Mining and Milling Company, at Seneca, has a 6-stamp mill, and the mine was operated during part of the year.

The placer mines of Plumas County are numerous, but there are few large producers. At Buck are the Greenbower and a number of smaller producers. At Crescent Mills are the Alpine and the Cadmus (a hydraulic mine). A few small sluicing mines were operated at Cromberg. At Eclipse are the Bird Creek and others, all sluicing properties. A considerable number of small placer mines were operated near Johnsville. At La Porte are the New Bunker Hill drift mine, Alturas Tailings, and Secret Diggings. Large numbers of Chinese also operate along Slate Creek. Some placer mining is also done near Lumpkin, at Meadow Valley, and at Mohawk. Small placer operations are reported from Nelson Point. The Costa mine and others are near Prattville. At Quincy are the Dutre and the Empire. Placers are also worked at Seneca, at Prattville, and at Taylorsville.

Among the unproductive mines of Plumas County the Caldwell group, at Buck, has an 8-stamp mill with concentrators, pans, and roasting furnace; the properties are worked in a small way. The Channel Peak Mining Company operated on Spanish Peak at an elevation of 7,045 feet, where an ancient river channel was being opened by tunnels. The Little California mine, at Buck, has a 5-stamp mill, but no ore was milled in 1908. The Crescent Mills Mining Company, at Crescent Mills, has a 32-stamp mill, but it was closed down during the year. The Feather River Consolidated Mining Company, at the same place, was doing development work. The Five Bears Mining Company, at Genessee, has a 5-stamp mill; copper ore is stored awaiting the completion of Western Pacific Railway; the mine is developed by a 1,300-foot tunnel. The Plumas Mohawk mine has 4 Huntington mills, but there was no work done

in 1908. The Crescent Hill Gold Mines Company carried on development work during the entire year, but made no output. The Long Valley Mines Company installed a 10-stamp mill in 1909; there is both quartz and placer ground on this property. The Elizabeth Gold Mining Company, at Spanish Ranch, has an 8-stamp mill, but no ore was crushed, work being confined to driving a tunnel for the ore body.

SACRAMENTO COUNTY.

Mine production of Sacramento County, Cal., in 1907 and 1908.

Year.	Gold.		Silver.		Total.
	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		
1907	38,263.32	$790,973	3,082	$2,034	$793,007
1908	56,407.91	1,166,055	3,058	1,621	1,167,676
Increase (+) or decrease (−)	+18,144.59	+375,082	−24	−413	+374,669

The increase in value of output of this county in 1908 was $374,669, which is even more than the increase shown in Butte, another gold-dredging county. All the mining operations in Sacramento County are in gravel. By far the largest proportion of the gold is derived from dredging operations. Since the last report was made there has been a merger of the various dredging companies operating at Folsom, and the Natoma Development Company, El Dorado Gold Dredging Company, Folsom Developing Company, and Ashburton Dredging Company have gone out of existence, all being now the property of the Natoma Consolidated Company of California, which has 12 dredges in that field. The dredge operations in the Folsom field are now very extensive; the new dredges built are large ones, and the old ones have been repaired and improved. The rock piles thrown up by the dredges in their work are now utilized for making macadam for roads, extensive rock-crushing plants having been established with a capacity of 4,000 to 5,000 tons of crushed rock daily. The cobbles are handled by mechanical shovels and transported to the crushers. After the rock piles are removed the surface is left level, and on this level ground, which has of course been worked out of its gold, orchards are planted. One of the great objections to dredge operations is thus being removed, and the ground is again utilized for agricultural operations. In the report for 1907, details of work in this field were given, and the conditions have not been changed except as to ownership of the dredges.

There are several drift mines in the county, mainly in the Blue Ravine region above Folsom, the largest operations being at the Channel mine. Sluicing in a small way is being carried on, and there is 1 hydraulic mine in operation. The gold output of all the drift mines in the county in 1908 was valued at $52,365; the hydraulic, at $569; the sluicing, at $3,925; and the dredging, at $1,109,196, a total of $1,166,055.

SAN BERNARDINO COUNTY.

In 1908 San Bernardino County produced 8,732.22 fine ounces of gold, valued at $180,511; 67,366 fine ounces of silver, valued at $35,704; 201,993 pounds of copper, valued at $26,663; and 117,024 pounds of lead, valued at $4,915, a total value of $247,793. This was a falling off in value, as compared with that of 1907, of $110,830. There was an increase in the production of gold and of lead. The copper output decreased very materially, as the value was $91,467 less than in 1907. There was a falling off in silver also, the yield in 1907 being 123,241 fine ounces, as compared with 67,366 fine ounces in 1908.

There are a few small quartz mine operators at Barstow, Amboy, and Bagby. The War Eagle Mining and Smelting Company has a 25-ton reduction plant, but the production was nominal. The Sinbad mine, at Barstow, furnished ore to Needles and to Pueblo smelters. The Fulton Gold Mining Company, at Barnwell, produced gold from the Shadow Mountain group. The Sagamore Mining Company, at Barnwell, only worked its claims about six weeks in 1908, the ore being taken from Alpha No. 1 and No. 2 mines; this company has a 50-ton concentrating mill with crushers and rolls. The Death Valley Arcalvada Consolidated Mines Company, at Cima, closed its mines in June, 1908, pending litigation. Ore was shipped carrying gold, silver-lead, and zinc, the latter being penalized. The largest values were in silver. The King Thebaw mine, at Cima, was operated for two months in 1908, its entire output being silver. The Alta Crown Copper Company, at Cima, only worked its property for three months of the year. The Standard Mines Company, at the same place, which has a 356-foot vertical shaft, sunk a 250-foot incline shaft during the year and did considerable drifting; the ore was shipped to smelters at Salt Lake. The operators of the Silver King, or Old Dominion mine, shipped some copper ore to Salt Lake. There was only a small output from the old Calico district, at Daggett. The Supply and O. K. mines, at Dale, have one 6-stamp and one 10-stamp mill. The property has been in litigation. The Ord Mountain Gold Mining Company, at Daggett, has a 5-stamp mill; the output was nominal. The Brooklyn Mining Company, at Mecca, is equipped with a 3-stamp mill and a Merrill's mill. The Virginia Dale Mining Company, at Dale, which has a 40-stamp Lane mill, made only a small yield. The Prodigal Son mine, at Danby, has a 2-stamp mill. The Siam Mining and Milling Company, at Danby, made a small shipment of ore to the smelters. The operators of the Green Lead worked over tailings only. The Garvanza Mining and Milling Company, at Leastalk, is equipped with a 100-ton crushing, concentrating, and lixiviation plant, which was only operated for three months, the power plant being inefficient. The mine itself was worked for nine months in the year, and is opened by a 210-foot vertical shaft and a tunnel 1,500 feet long. From the Avawatz Crown mine, at Silver Lake district, there was made a small shipment of ore to the smelter. The Bagdad-Chase Mining Company, of Barstow, operated the mill the entire year on tailings from ores of the Camp Rochester mine. The Roosevelt Mining Company, of Stagg, sold its ore to the Peyton Chemical Company, and did 1,500 feet of development work during the year. This mine has 2 incline

shafts 300 to 480 feet deep, and 2 shallower vertical shafts. There is only 1 small productive placer mine in this county.

Among the unproductive mines of San Bernardino County the Orange Blossom Mines and Milling Company, at Bagdad, commenced operations in 1909. The mine is equipped with a 20-stamp concentration plant. The power plant is a 150-plant power gasoline engine, 9 miles away, with an electric transmission line. The Pon de Rosa Copper Company, at Bagdad, has a gasoline-power hoisting plant, and considerable development work was done on the mine in 1908. The Fremont Mining and Milling Company, at Barstow, continued development throughout the year. The Grant Ledge Mining Company, and the operators of the Manvel, at Barnwell, did development work. The Ivanhoe Mining and Milling Company, at Cima, has a 20-ton roller-mill crushing plant, and shaft and drift work were continued during 1908. The Bonanza King Development Company, at Fenner, has a 10-stamp mill, but it has been idle since September, 1907. Development work has been done on the Big Chief mine, at Hart. The California Gold and Copper Company, near Von Trigger station, spent much money in development work and piping water to the mine, but is not yet producing. The Colorado River Gold and Copper Company, at Needles, worked part of the year.

Of the 48 deep mines reporting product, 37 are gold mines, 2 silver, 1 copper, 2 lead, 4 silver-lead, and 2 copper-lead.

SHASTA COUNTY.

Mine production of Shasta County, Cal., in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		
1907	38,312.85	$791,997	560,926	$370,211	23,457,417	$4,691,483	$5,853,691
1908	54,752.37	1,131,832	976,596	517,596	33,852,842	4,468,575	6,118,003
Increase (+) or decrease (−)	+16,439.52	+339,835	+415,670	+147,385	+10,395,425	−222,908	+264,312

There was a material increase in the total output of Shasta County in 1908 as compared with that of 1907, which amounted in value to $264,312. Shasta County is by far the leading county of California in the production of metals, which is owing mainly to the operations of the copper companies. The county is the largest producer of copper and of silver in the State, and also stands high as a gold producer, ranking seventh among the 7 counties which made a yield of over a million dollars each in 1908.

The total number of mines from which product was reported from Shasta County in 1908 was 39, of which 32 were deep mines, including 28 gold and 4 copper properties. There were 7 productive placers, including 1 hydraulic mine, 2 dredges, and 4 sluicing mines.

The yield, valued at $6,118,003 for 1908, is the largest ever made by Shasta County, except in 1901, at a time when copper was very high, when the value of the yield of the county was $6,737,571. The gold output of Shasta County increased $339,835 in 1908 over that of 1907.

There were also 415,670 more ounces of silver produced, with an increase in value of $147,385. The copper output of the county increased 10,395,425 pounds in 1908 over the product of 1907, but the total values decreased by $222,908, owing to the low price of the metal.

The tonnage of ore treated in Shasta County was the largest in the State—556,922 tons, of which 99,867 tons were siliceous and 457,055 were copper ores. The yield from this ore is given in the preceding table. From the deep mines of the county in 1908 were obtained 53,159.96 fine ounces of gold, valued at $1,098,914, and from the placers 1,592.41 fine ounces, valued at $32,918. The deep mines yielded 976,309 fine ounces of silver, valued at $517,444, and the placers 287 ounces, valued at $152. The gold obtained from the siliceous ores was 34,056.24 fine ounces, valued at $704,005, and that derived from the copper ores was 19,103.72 fine ounces, valued at $394,909. The silver from the siliceous ores was 66,362 fine ounces, valued at $35,172, and the silver from copper ores was 909,947 fine ounces, valued at $482,272. The siliceous ore yielded, therefore, $739,177 in gold and silver, and the copper ore yielded $877,181, a total of $1,616,358 in gold and silver from deep mines.

The 4 chief copper companies in Shasta County buy large quantities of siliceous ore for fluxing, thus enabling miners to work their gold or silver mines without having to put up reduction works, as they can sell to the smelter all the ores they mine. Ore of this character is bought also from neighboring counties, and even from Oregon. Shasta County yielded about nine-tenths of the total copper ore of the State in 1908.

The mine of the Brunswick Mining Company, of French Gulch, is equipped with a 10-stamp mill and was operated for ten months of 1908. The El Dorado and Eureka group, at the same place, made a small output, as did the Evening Star. The Empire was also a producer. The Gladstone, owned by the Hazel Gold Mining Company, at French Gulch, was the largest producer of gold from siliceous ore in the county. The mine is equipped with a 20-stamp mill, and is developed through a vertical shaft 550 feet deep and a tunnel 3,600 feet long. The Milkmaid group, at the same place, made a product and did considerable development work during the year. The Peggie and Nevada mines were producers in a small way. The Sybil Gold Mining Company shipped its ore to the smelter. The Western Exploitation Company was a small producer, as was the Great Falls, at Igo. All the ore from the Original Quartz Hill mine was treated at the smelter of the Mammoth Copper Company, which now owns the mine. The Uncle Sam mine of the Virginia Mining Company, at Kennett, has a 20-stamp mill, not in operation, the mine having been worked by lessees and the ore shipped to the smelter.

The Pittsburg and Mount Shasta Gold Mining Company, at Keswick, has been developing for the last six years, and for the last two years with improved machinery. The main working tunnel is 1,825 feet long. The Midas Gold Mining Company, at Harrison Gulch (Knob post-office), has a 20-stamp mill, with concentrators, Ropp roasting-furnace, and cyanide plant. This mine is a large producer and is developed by 3 shafts of 200, 600, and 1,000 feet vertical depth, respectively, and 8 tunnels. In 1908 the company sank 300 feet of shaft and ran 2,800 feet of tunnels. There are 2 parallel veins in this mine. The Yankee John Gold Mining Company, near Larkin, operated the entire year and shipped its ore to the smelters. The Mad Ox

mine, at Stella, has a 10-stamp mill, and was worked part of the year. The Evening Star, at Whitehouse, has no reduction plant, and supplies ore to smelters, and the same is the case with the Reid Mining Company, at the same place. The Utah and California Gold Mining Company also made considerable production at Whitehouse.

There are 4 large productive copper companies in Shasta County having smelting plants at which they treat ores from their own mines and purchase or handle custom ores as well. The pioneer of these is the Mountain Copper Company (Limited), which works both the Iron Mountain and the Hornet claims, and has an extensive smelting plant at Keswick. A railroad connects the mines and the smelters. This smelting plant has not been operated for some time, litigation as to damage from fumes having caused the company to close it down and build a new smelting plant on San Francisco Bay, above Martinez, where the company's ores are now treated, as well as those purchased. The Balaklala Consolidated Copper Company, at Coram, has a 1,250-ton smelter, consisting of 3 blast furnaces, 4 roasters, reverberatories, and converters. Only part of the plant was operated in 1908, and that for only two months, though it has been in full blast since. The ore is delivered from the mine bins to the smelter by a wire-rope tramway. The Mammoth Copper Mining Company, at Kennett, is the most productive of Shasta County copper companies. There are 5 blast furnaces at the smelting plant and 2 converters. The Bully Hill Copper Mining and Smelting Company, at Winthrop, has a 350-ton smelter. The ore came from the Bully Hill, Rising Star, and Copper City mines.

The placer mines of Shasta County consist of 1 hydraulic, 2 dredging operations, and a few small sluicing mines, which produced altogether $33,070 in 1908, most of this coming from dredging work.

Among the nonproducing mines, the Delta Consolidated Mining Company, at Bayles, did only development work and construction on a narrow gage railway. The Original Quartz Hill, at Buckeye, is now under lease to the Mammoth Copper Company. The Shasta Grand, at Castella, is being developed, as is the Golden Calf, at Copley. The Great Western Gold Company, operating the Afterthought and Copper Hill mines, at Ingot, which has a smelting plant and was a large producer in 1907, was idle in 1908. The Golinsky mine of the American Smelters Securities Company was closed during the year.

The Shasta May Blossom Company, at Kennett, reported having done 3,000 feet of tunnel and shaft work in 1908. The Trinity Copper Company, at Kennett, did not begin to operate until the latter part of 1908, and is under contract with the First National Copper Company, of Coram, for the smelting of ore. The Vulcan Copper Company has been driving a 1,000-foot tunnel to cut the main lode and to explore by diamond drill. The Empire Mining Company, at Knob, and the operators of the Korte group, at Larkin, carried on development work. The Mountain Monarch Company, of Redding, also did considerable development work in 1908. The Gold Leaf Consolidated Mines Company, in Lower Springs district, was in litigation, but this is now settled and extensive development is planned. The Mascot mine, at Shasta, the Mount Shasta Gold Mines, at Shasta, the Gambrinus mine, at Stella, and the Tarantula reported development work.

SIERRA COUNTY.

The total production of Sierra County in 1908 was valued at $414,543 in gold and silver, as compared with $486,525 in 1907, a decrease of $71,982. The yield in 1908 was 19,960.78 fine ounces of gold, valued at $412,626, and 3,617 ounces of silver, valued at $1,917. There were 76,422 tons of siliceous ore treated in Sierra County in 1908, yielding 14,657.38 fine ounces of gold, valued at $302,995, and 2,102 ounces of silver, valued at $1,114. The gold derived from placers amounted to 5,303.40 ounces, valued at $109,631, and there were also 1,515 ounces of silver, valued at $803. Of this placer gold, $41,521 came from 6 hydraulic mines, $30,613 from 13 drift mines, and $37,497 from 18 sluicing mines. There were 37 placer mines which were productive in the county in 1908 and 13 quartz mines, or 50 producing mines in all. It is to be noted that while the deep mines of the county yielded $302,995 in gold in 1908, the placers yielded but $109,631, showing that the quartz interests of the county are now more important than the gravel. Indeed, the quartz development at Alleghany and Forest attracted more attention than those in any other part of California during the latter part of 1908 and the early part of 1909. A number of old mines have been reopened in that region, some of which are making an important yield. A large amount of prospecting and development work has been going on in Sierra County as the result of these recent discoveries. In 1907 the quartz mines of the county produced a total in gold and silver of $391,847, and in 1908 the yield from the same source was $87,738 less. Notwithstanding this, the quartz developments in 1908 were very extensive, and the yield of 1909 should be very much larger.

Among the deep-mine producers the El Dorado Mining Company, at Alleghany, has a 10-stamp water-power mill, and the mine is developed by a tunnel 1,100 feet long, 530 feet of which was run in 1908. The Tightner Consolidated Quartz Gold Mining Company has no reduction works and employs but few men, yet it is a large producer. It was the discovery of high-grade ore in this mine which attracted attention to the quartz mines of Alleghany. The Rainbow Gold Mining Company, at the same place, has a 10-stamp mill and the mine is developed by a 2,900-foot tunnel. The Lassiat Gold Mining and Milling Company is a small producer at Downieville. The Alice Mining Company, at that place, had a 5-stamp mill in 1908 and increased it to 10 stamps later. This property has now been consolidated with the Sovereign Mines Company. The Alta Sierra Mining Company, owning the Keystone mine, at Sierra City, has a 10-stamp mill; both mine and mill were operated. The Cleveland Gold Mining Company, at the same place, made a small output, as did the King Consolidated Mining Company and the Roman and Klondike mines. The Sierra Buttes Mining Company, at Sierra City, has a 40-stamp and a 20-stamp mill with a 300-ton cyanide plant. This old well-known mine is opened by 9 tunnels from 1,500 feet to 3 miles in length; it was abandoned for some years, and was reopened by the present company.

The following are among the producing placer mines of Sierra County: The Depot Hill hydraulic, near Camptonville, Yuba County; several small mines at Alleghany; Hilo drift, Mayday-Undine hydraulic, and Telegraph drift, at Downieville; Maple Grove drift and

Omega mine, at Forest; Bellevue drift and North American Consolidated hydraulic, at Gibsonville; several small mines at Pike; the Erie and Slate Creek properties, at Port Wine; the Neocene hydraulic, at Scales; the Imperial and others, at Sierra City; Brown's Flat drift and others, at St. Louis; Goard drift, Queen Flat, and Chinese mines, at Table Rock. Among these the Depot Hill, Bellevue, and North American Consolidated are the largest producers.

Among the nonproductive but developing mines are the Golden King, at Alleghany, which has a 10-stamp mill with concentrators, and the Ophir at the same place. In the Red Star drift mine development work was carried on the entire year. The Triple Pocket, at Downieville, has a 5-stamp mill. The Alaska mine, at Pike, has a 20-stamp mill with concentrators, but it was not run in 1908, work being confined to unwatering the mine. The vertical shaft on this mine is 560 feet deep and the tunnel 1,800 feet long. The Butte Saddle Gold Mining Company, at Sierra City, has a 10-stamp mill which was repaired ready to run in 1909. The operators of the Hilda drift mine drove a tunnel to tap the gravel channel. The Phoenix has a 20-stamp mill, electric power plant, and aerial tramway.

Other mines provided with mills, but on which development work only was done are the American Exchange, the Buffalo, the Chipps (now the Swastika mine), and the Primrose.

SISKIYOU COUNTY.

In 1908 Siskiyou County produced 24,388.55 fine ounces of gold, valued at $504,156, and 11,557 ounces of silver, valued at $6,125, together with 6,000 pounds of copper, valued at $792, a total value of $511,073, which was an increase of $110,019 over the figures of 1907. Of this increase $106,139 was in gold. The deep mines of the county yielded from 20,030 tons of ore 11,720.78 fine ounces of gold, valued at $242,290, and 5,019 ounces of silver, valued at $2,660, or $244,950 in silver and gold. The placers yielded 12,667.77 fine ounces of gold, valued at $261,866, and 6,538 ounces of silver, valued at $3,465, a total of $265,331. The placer mines are thus shown to have yielded more in 1908 than the quartz mines. There were 139 productive mines in Siskiyou, the largest number of any county in the State. There are 44 productive deep mines, 1 of which is a copper property, and 95 placer mines. Of these latter 41 are hydraulic, 2 dredge, 2 drift, and 50 surface placers. This is the largest number of productive placers shown by any county in California, and in number of productive quartz mines Siskiyou is only exceeded by San Bernardino County, which has 4 more. There are many Chinese at work in this county in the hydraulic and placer mines.

Of the producing deep mines, the Monarch, at Black Bear, has a 3-stamp mill and was operated during the summer of 1908 only. The operators of the Eaton group, at Callahan, put in a small mill during the year and operated it for a short time. The McFadden was operated for five months and supplied ore to the smelter. The work at the Helena Mining Company's property was done by lessees. The Advance Gold Mining Company, at Etna Mills, did mainly development work, and its output was small; and the Diamond group and Finley & Johnson were both producers. The Lucky Strike is a new mine. The Taylor Lake Mining Company has a 2-stamp mill

with concentrators, and the ore milled yielded concentrates of high grade. At Fort Jones the Get There is a pocket mine. The Consolidated Gold Run, at Gilta, has a 10-stamp mill with concentrators. The mine was operated only about a month in 1908. The Pilot Knob Company, at Gottville, operated 2 groups of claims but only commenced crushing ore in its 5-stamp mill at the end of the year. The Luke Shaw, at Greenview, was an important producer. In the Huey Hill mine decomposed quartz veins are worked. The Elk Creek Mining Company, operating on the Providence group, at Hawkinsville, has a 3-stamp mill, and did considerable development work in 1908. The Indian Girl mine, at Hornbrook, has a centrifugal mill. The operators of the Boss group, at Rollin, work the ore in an arrastre. The Stevens-Ball mine, at Rollin, has a 20-stamp mill with concentrators, which was worked only half time in 1908, but a great deal of development was carried on. The operators of the Brown Bear, at Sawyer's Bar, have a 4-stamp mill, did considerable tunnel work during the year, and milled ore from the Crystal Fraction claim. The Jeffries, at Scott Bar, was operated for three months, and the high-grade ore obtained was treated in a hand mortar. The Lucky Bob, at Snowden, has a 2-stamp mill. The Yellow Butte mine, at Walker, supplied a few carloads of copper ore to the smelter. The Punch Creek mine, near Yreka, was among the larger producers; and the Wheeler Mining Company worked for three months in 1908 and had its ore crushed in the 5-stamp mill.

The placer producers in Siskiyou County in 1908 were the small operators in surface mines, at Black Bear; Scott River Dredging Company and small mines, at Callahan; Banner Mining Company, Salmon River Hydraulic and Ditch Company, and Burgess Hydraulic mines, at Cecilville; Bloomer, Knudson, Nigger Hill, Nordheimer Mining Company hydraulic, and small operators, at Forks of Salmon; Fernandez hydraulic, at Fort Jones; Parrott hydraulic, at Gazelle; small operators, at Gottville; Denny Bar Mining Company, Old Pinery hydraulic, and small mines, at Greenview; small mines, at Hamburg; Michigan Salmon Mining Company hydraulic, at Gilta; Cottage Grove and Pennsylvania and other small sluice mines, at Happy Camp; Fillipi, Sylvester & Greenwood, and many small mines, at Hawkinsville; placers, at Hilts; Klamath River Gold Mining Company's dredge, at Hornbrook; small hydraulic mines, at Hutton and at Nolton; Oak Bar Hydraulic Mining Company and Collins sluicing mine and many smaller properties, at Oak Bar; New Pinery, working over tailings, and Wright & Fletcher, hydraulic, at Oro Fino; Burns and smaller mines, at Rollin; Bigelow, Free Trade and Myers, Curran & Finley Patent, hydraulic mines, and Dunphy, Jilson, Klein, and Tonkin, sluicing mines, at Sawyer's Bar; Andrews drift mine, Milne, and Quartz Hill, hydraulic mines, with many small properties, at Scott Bar; and small mines at Seiad, at Somesbar, at Walker, and at Yreka.

Of the deep mines reporting no product in the county, the Black Bear Consolidated Company did not run its mill, though development work was carried on during the year. The White Bear was operated for a short time, but there was no output. The Gold Dike Mining Company, at Cecilville, has 2 Huntington mills with concentrators, and development work was carried on for part of the year. The Bonanza group, at Etna Mills, has been developed by a tunnel. The

Salmon Summit Mining Company, at Gilta, carried on development work in 1908, and put up buildings for a new mill. The Shaft Rock, at Gottville, has a Lane roller mill. The Sundown Luzon was developed by a crosscut tunnel. The operators of the Bonanza No. 2, at Hawkinsville, erected a mill in 1909.

TRINITY COUNTY.

In 1908 Trinity County produced 29,167.42 fine ounces of gold, valued at $602,944, and 8,055 ounces of silver, valued at $4,269, a total value of $607,213, an increase as compared with 1907 of $69,498. Of this increase, $67,628 was in gold. The 24 productive deep mines of the county in 1908 treated 20,796 tons of ore from which was derived 8,980.05 fine ounces of gold, valued at $185,634, and 4,057 ounces of silver, valued at $2,150, a total value of $187,784. The 66 placers yielded 20,187.37 fine ounces of gold, valued at $417,310, and 3,998 ounces of silver, valued at $2,119, a total of $419,429. Of producing placer mines numbering 66, there were 49 hydraulic, 3 drift, and 14 surface mines. There are more productive hydraulic mines in this county than in any other in the State. Reports were received from 68 nonproducing properties. The hydraulic mines of the county yielded $409,781 in gold in 1908, the drift mines $375, and the surface placers $7,154. The largest and most productive hydraulic mine in the United States, the La Grange, is in Trinity County.

The total tonnage of the county, all from siliceous ore, was 20,796 tons, a decrease of 4,352 tons in 1908 as compared with the tonnage of 1907.

The small mill of the Bear Tooth mine, at Burnt Ranch, was operated only a part of the year. The Golden Jubilee Mining and Milling Company, at Carrville, has a 10-stamp mill, with concentrators and a slime and cyanide plant, installed in 1908, but operated only during December. This mine is opened by 5 tunnels. The Brown Bear Mining Company, at Deadwood, has a 10-stamp mill with concentrators, which was run for eight months on day shift, but extensive development work was carried on the entire year. These properties are opened by 8 working tunnels, the lowest one being 1,060 feet deep and 5,000 feet long. Much leasing work was in progress in addition to that performed by the company itself. The Goodyear & Richards, Lappin Mining Company, Valentine, Slater, and other mines are producers, at Deadwood and Eastman Gulch near by. The Globe Mining Company, at Dedrick, has a 5-stamp mill. The mine is at the head of Canyon Creek in the higher mountains and is not operated in the winter on account of the deep snows. The Hunter and Mountain Boomer are small producers, at Denny. The Dorleska Gold Mining Company, at Dorleska, is equipped with a 10-stamp mill and a Huntington mill. The property was under lease, and no development work was done. The Gold Bug and Klondike, or May group, is equipped with a 5-stamp mill, and work was carried on for three months only. The same was the case with the Yellow Rose of Texas, which has a small mill. There are several small mines producing at this place, some of them using self-discharging arrastres. The Bullychoop Gold Mining Company, near Douglas City, has a 30-stamp, plate-amalgamation mill. The mine is being developed by tunnels and was operated irregularly owing to shortage

of water. The Texas Jack, at the same place, has a 3-stamp mill and concentrators. The Yellowstone group, at Helena, was a small producer, as were the Jacoby and White Cloud mines, at Lewiston. The Fairview Mining Company, at Minersville, has a 40-stamp mill which was operated the whole year. The Bonanza King mine, near Trinity Center, has a 20-stamp mill, and was worked for a part of the year.

The placer producers in Trinity County are a number of small mines at Big Bar; China Creek or Lassen and Hawkins Bar hydraulics, at Burnt Ranch; North Trinity Mining Company hydraulic and small mines, at Carrville; Underground Treasure and Trinity Placer Mining Company sluicing mines, at Coffee; small mines, at Denny and at Dorleska; Indian Creek, Steiner's Flat, Spring Gulch, and Union Hill, hydraulic mines, at Douglas City; Big Creek Mining Company and others, at Hayfork; Bayles & King and Schlomer, hydraulic mines, at Helena; Chapman & Fisher, Cummings, Dannenbrink, Post, and many smaller mines, at Junction City; Eastman Gulch, English Tom, hydraulic mines, and smaller mines, at Lewiston; Bentley Mining Company and Trinity Gold Mining Company, hydraulic mines, at Minersville; Snow Gulch and Sykes Mining Company, hydraulic mines, and others, at Trinity Center; and Poverty Flat, Hupp, La Grange Mining Company, Chapman, hydraulic mines, and a number of smaller mines, at Weaverville.

Of the nonproducing but developing mines in the county, are the property of the Blue Jay Mining Company, at Carrville; the Gold Ridge mine, at Coffee; the Sherwood, at Denny; and the Oriole mine, at Douglas City. The Trinity River Mining Company, near Lewiston, drove a tunnel 1,480 feet long in order to turn Trinity River through the Big Horseshoe Bend, and lay bare for mining 1½ miles of virgin river channel. The tunnel was completed early in 1909.

TUOLUMNE COUNTY.

Mine production of Tuolumne County, Cal., in 1907 and 1908.

Year.	Gold.		Silver.		Lead.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces*		*Pounds.*		
1907	39,032.63	$806,876	9,778	$6,453	6,000	$318	$813,647
1908	38,639.63	798,752	22,136	11,732	.....	.....	810,484
Increase (+) or decrease (−)	−393.00	−8,124	+12,358	+5,279	−6,000	−318	−3,163

The decrease in total output of Tuolumne County in 1908, as compared with that of 1907, was merely nominal, showing that mining conditions were about the same in the county in each year though in 1908 there were 69,007 more tons of siliceous ore treated than in 1907. There were 42 deep mines which were productive in the county in 1908, against 35 reporting in 1907. There were also 4 drifts and 4 surface mines productive in 1908, making 50 productive mines in all, both placer and deep.

The deep mines in 1908 yielded for treatment 263,216 tons of ore, virtually all siliceous, from which were obtained 38,040.02 fine ounces of gold, valued at $786,357, and 22,000 ounces of silver, valued at $11,660, a total value of $798,017. No lead ore was produced. Aside from 5 tons, the ore output of the county was treated in gold and silver mills. The 263,211 tons of ore treated at gold and silver mills yielded in bullion $488,830 in gold, an average of $1.86 per ton, and $9,435 in silver, or an average of 3 cents per ton, or a total saved on the plates of $498,265, and an average of $1.89 per ton.

From this milling ore 9,334 tons of concentrates were obtained, which yielded $296,637 in gold, an average of $31.78 per ton, and $2,200 in silver, an average of 24 cents per ton, or a total of $298,837 in gold and silver, and an average of $32.02 per ton.

The total ore milled yielded a total of $785,467 in gold, or an average of $2.99 per ton in gold. The total value of silver saved was $11,635, or 4 cents per ton. The total yield of both gold and silver, on the plates and from concentrates, was $797,102, or an average yield of $3.03 per ton.

Tuolumne is one of the five Mother Lode counties of the State in which the veins are wide and the grade of ore low, but there are also numerous "pocket" mines, where ore of a very high grade is mined. These latter properties, usually worked in a small way, are sometimes operated for a year or more before a "pocket" of any size or richness is discovered, but are seldom worked continuously or with any large force of men.

Of the productive deep mines of Tuolumne County the Big Casino Mining Company, at Big Oak Flat, has a 20-stamp mill. The property was operated intermittently during the first half of 1908 and steadily for the last six months. A 500-foot incline shaft was sunk in 1908. The Nonpareil Gold Syndicate (Limited) at the same place has a 10-stamp mill with concentrators, and the mine is developed by a 250-foot shaft and a 750-foot tunnel. The Ophir and the Red Jacket at the same place are small producers. The Shibo, at Blanchard, has a prospect mill with concentrator; after operating five months the mine was closed for lack of water, but work was resumed later. The mine of the Eagle Shawmut Mining Company, at Shawmut, the largest producer in the county, is developed through an incline shaft 2,350 feet deep. It is equipped with a 100-stamp mill and concentrators, together with a 20-ton chlorination plant. The property was operated for nine months in 1908, water shortage causing cessation of work. The largest producer at Columbia is the Experimental Gulch mine, which has a 3-stamp mill and is developed by a 250-foot shaft and a 500-foot tunnel. The drain tunnel is being extended. The mine was operated for seven months only. Smaller producers at this place are the Burnham, Toulumne, Ethel Mining Company (with a Huntington mill installed in 1908), El Porvenir Mining Company, and Golden Gate. At Groveland the Cosmopolite Mining Company made a short mill run in its 5-stamp mill, but the mine was operated throughout the year. The Ellen Winton Mining Company operated mill and mine a short time in 1908. The Harvard Mines, at Jamestown, are equipped with 60-stamps, but the average number of stamps operated during the year was 40. The property is developed by 2 vertical shafts 700 and 950 feet deep, respectively. The Rawhide mine, at Jamestown, developed by an 1,800-foot incline

shaft, is equipped with a 40-stamp mill and concentrators, and a chlorination and cyanide plant. The App, at Quartz, developed by a 1,300-foot incline shaft, has a 60-stamp mill with concentrators. Both the Rawhide and the App are owned by the App Mining Company. The Santa Ysabel Gold Mining Company, at Quartz, has a 40-stamp mill with concentrators. All work on the mine in 1908 was done by lessees. The Sugarman, at Sonora, has a small Huntington mill and was operated a short time in 1908 by lessees. Many small pocket properties were worked in the vicinity of Sonora during the year. The Bagdad-Chase Mining Company, at Soulsbyville, has a 15-stamp mill, and developed and prospected the Soulsby mine during the entire year. Since the close of 1908 the "lost ledge" in this mine has again been found, just as the company was about to cease operations. A small yield was made by the Good Shepherd and Parole mines at the same place. The Jumper Gold Syndicate of California (Limited), at Stent, has an 80-stamp mill with concentrators, and operated for four months, the property being under option the rest of the time. The Mohican Mining Company, at Tuolumne, worked the Lillian mine and ran its 5-stamp mill a short time. The Providence Consolidated Mining Company, at the same place, has a 20-stamp mill with concentrators, but only operated a few months. The Arbona mine, at Tuttletown, has a 10-stamp mill with concentrators, and is developed by an incline shaft 620 feet deep and a tunnel 200 feet long; during 1908 the operators were engaged in opening ore bodies and equipping the property with compressors, pumps, and a mill. The Cross Consolidated mine, at the same place, was operated about seven months of the year.

Of nonproducing mines in the county the Republic Gold Mining Company, at Columbia, is equipped with a 10-stamp mill. The Springfield Tunnel and Development Company continued development. The Duleek Gold Mining Company has a 10-stamp mill at Groveland, and the Eclipse and Fiesta Gold Mining Company, owning the Eclipse and Kanaka mines, has a 10-stamp mill with concentrators and cyanide plant. The Clio Mining Company's property, at Jacksonville, was closed by litigation during the year. The small mill of the Hardtack mine, at Tuolumne, was idle, but development work was continued in the mine throughout the year. The New Era mine has a 10-stamp mill and is opened by a vertical shaft 450 feet deep and by tunnels. The United Mines Company did much development work. The Black Oak mine, at Soulsbyville, was being developed.

The productive placers of the county in 1908 were the Gold Nugget sluicing mine at Columbia, various small sluicing properties at Confidence, the Potter drift mine at Jamestown, a sluice mine at Shawmut, and 2 drift mines at Tuolumne.

YUBA COUNTY.

In 1908 Yuba County produced $2,004,483 in gold and silver, as compared with $1,772,957 in 1907. The increase in value of gold for the year was $267,716. The few quartz mines in the county produced 169 tons of ore, yielding 1,738.65 fine ounces of gold, valued at $35,941, and 4,726 ounces of silver, valued at $2,505. The placers

yielded 96,679.61 fine ounces of gold, valued at $1,998,545, and 14,136 ounces of silver, valued at $7,492. There are altogether 39 productive properties in the county, of which 4 are deep mines. The placers consist of 1 hydraulic mine, 14 dredges, 1 drift mine, and 19 surface or sluicing mines. Some of the companies own several dredges, and these are enumerated by the number of dredges operating, not by number of companies. The gold yield of the county from hydraulic mines was $543; from drift mines, $60; from surface placers, $28,863; and from dredges, $1,969,079. This statement shows the predominance of the dredging industry in Yuba County. There are now extensive shops in this county where the largest dredges in use are manufactured and repaired. The dredging fields in the county have been taken up in purchase, and the number of dredges is yearly increasing.

The productive quartz mines in Yuba County are the Cornwell, Nanette, B. A. C. (or Solano Wonder), and Taylor. Most of them are at Brownsville, and they have either small reduction plants or none at all. The larger proportion of the quartz output came from a single "pocket." The auriferous gravel or placer mines of the county which are productive are a number of small properties, at Brownsville; the Industry placer, at Browns Valley; the Weeds Point hydraulic, at Camptonville; the Labadie sluice at Dobbins; dredges of the Archimedes Gold, Mammoth Gold, Marysville, and Yuba Consolidated Gold Fields dredging companies, near Marysville; and near the same place a number of small (including Chinese) sluicing properties. At Smartsville are 3 sluicing mines; and near Wheatland the Bear River dredge of the Oroville Dredging Company was in operation.

Among the nonproducing mines in this county are the Clark, which was being reopened at Brownsville, but whose 10-stamp mill was idle. The operators of the Bessie, at Browns Valley, deepened its shaft and did considerable drift work in 1908. The Dannebrog and Pennsylvania mines, also at Browns Valley, are equipped with mills. The Snowden Hill drift mine, at Camptonville, was worked eight months of the year, the property being equipped and the bedrock tunnel continued. The Santa Rosa mine, at Rackerby, has a 5-stamp mill and concentrator and was being opened. The Tarr Mining Company, at Smartsville, has been making extensive improvements. The ditch has been enlarged, and a plant is being installed to handle 7,000 cubic yards of cemented gravel daily; it is intended also to install a plant to save the platinum values. At the Colling & Demfrey drift mine an incline shaft was sunk to tap the gravel deposit.

OTHER COUNTIES.

Colusa County.—There was only one mine which made any yield in this county in 1908. This is a quartz property, the output of which was in gold and silver.

Del Norte County.—The few deep mines of Del Norte, made a production of 259 tons of ore, yielding 45.96 ounces of gold valued at $950, and 72,690 pounds of copper, valued at $9,595. The placers yielded 122.78 fine ounces of gold, valued at $2,538, and 36 ounces of silver, valued at $19. The total output of the county was $13,102 in 1908, as compared with $881 in 1907, an increase of $12,221 for

1908. The county appears as a copper producer for the first time. The placers are all near Crescent City, 2 of them being hydraulic and 2 sluicing mines. The principal ones are the Jones Creek Mining Company, Whitney, McCleary & Allen, and Williams.

Fresno County.—The output in 1908 of Fresno County was $1,013 in gold and $11 in silver from deep mines, and $41 in gold from a placer mine, a total value of $1,065, which was a decrease of $1,362 for 1908 as compared with 1907. The producing placer is at Toll House. The producing deep mines are the Weatherby, at Auberry; Sampson, at Dunlop; and the Cook and the Davies, at Pollasky.

Imperial and San Diego.—These adjoining counties are in the extreme southern portion of the State, and, as Imperial was formerly a portion of San Diego County, the output of its mines was formerly credited to the latter county. The total yield from Imperial County in 1908 was valued at $6,551. Of this $367 in gold and $108 in silver came from deep mines and $5,481 in gold and $15 in silver from placers. This placer gold was virtually all obtained from dry-washing operations at Glamis, Picacho Basin, and Pot Holes. There were 4 producing deep mines in the county in 1908. The total output of San Diego County was valued at $7,006 in 1908, as compared with $7,490 in 1907. The deep mines in 1908 produced 1,306 tons of ore, yielding 312.84 fine ounces of gold, valued at $6,467, and 147 ounces of silver, valued at $78. The placer yield was $453 in gold and $8 in silver. Both placers are small sluicing operations. There were 10 deep mines producing. Reports were received from operators of 27 mines which made no yield in 1908.

Lassen and Modoc Counties.—These two adjoining counties are in the extreme northeastern part of California. From 991 tons of ore, Lassen County deep mines produced 352.36 fine ounces of gold, valued at $7,284, and 1,477 ounces of silver, valued at $783, 205 pounds of copper, valued at $27, and 7,143 pounds of lead, valued at $300. The value of the total output for 1908 was therefore $8,394 all from 5 deep mines. There were no productive placers. The Blue Bell, at Hayden Hill, is a small producer, as is the Coyote at the same place, though the latter has a 10-stamp mill. The Lassen Mining Company, at Hayden Hill, has a 100-ton dry-crushing cyanide mill, but it was not operated during 1908, the small yield having been obtained from "bullion sweeps" or slag in the melting room. The mine has a shaft 835 feet deep, and 3 miles of underground workings. Development work in the mine was done in 1908. The Lassen County Milling and Mining Company has a 10-stamp water-power mill located 3 miles from the mine. During 1908 a 25-ton cyanide plant was installed. The mill was run about three months, and the cyanide plant was run on tailings for four months. Alexander & Knoch, of Susanville, shipped to the smelter a small quantity of ore carrying gold, silver, copper, and lead. Modoc County is not credited with any yield, the output of 2 quartz mines at Adin being so merely nominal that it has not been considered in tabulation. The mines in Hoag district, near Fort Bidwell, are being developed, but, there being no mill in that locality, there has been no output as yet.

Los Angeles, Orange, and Ventura counties.—This group of counties on the southern coast of California are not large producers of the precious metals. From Los Angeles County reports were received

from operators of 10 nonproducing properties, and 4 nonproducers answered in Orange County. From Ventura County reports were received from 8 nonproducing mines, and 1 small placer reported a nominal yield. In 1907 there were 3 producers in Los Angeles County, 1 in Orange, and 1 in Ventura, all deep mines. Their combined output was $23,022 in 1907, but none of them reported any yield in 1908.

Madera, Merced, and Stanislaus counties.—These are three adjoining counties in the central portion of the State. Madera County in 1908 had a total yield valued at $54,427 from 11 deep mines. As the total yield in 1907 was valued at $18,602, the increase in 1908 amounted to $35,825. There were 6,268 tons of ore treated in the county in 1908, yielding 2,182.05 fine ounces of gold, valued at $45,107, 2,385 ounces of silver, valued at $1,264, and 61,030 pounds of copper, valued at $8,056. The Texas Flat Mines Company, at Coarse Gold, was the largest producer of gold. The mine is equipped with a 20-stamp mill and concentrators, and is developed through an incline shaft 660 feet deep. It was worked eight months of the year. The Moonlight, at Grub Gulch, is a small producer, as is the Bullfrog, at O'Neals. The Eliza Jane, Lawsuit, and Hanover, at O'Neals, are small producers. The Misfortune mine, at O'Neals, made a considerable output of gold. The Santa Rosa, at the same place, is also a producer. The Buchanan mine, at Raymond, is developed by tunnels. The company has no smelter and ships its copper ore to the Mammoth Copper Company, in Shasta County. Merced and Stanislaus counties made a combined yield, valued at $184,146, from auriferous gravels.

Monterey and San Luis Obispo counties.—These two contiguous coast counties are usually small producers each year. In 1908, 1 deep mine, at Jolon, in Monterey County, made a small output, and there was some production from a few placers at the same place. The total yield of the county for 1908 was valued at $1,327 in gold and silver. One small placer, in San Luis Obispo County, reported a nominal yield.

Riverside County.—This county yielded an output valued at $7,094 in 1908, which was $3,232 more than that of 1907. The deep mines produced 337 tons of ore, which yielded 260.45 fine ounces of gold, valued at $5,384, 204 ounces of silver, valued at $108, and 8,318 pounds of copper, valued at $1,098. The few placers, at Mecca, yielded $500 in gold and $4 in silver. The Gold Park Consolidated Mining Company, at Banning, has a Bryan mill, and continued development work in 1908. The operators of the Ironwood or McCoy Mountain mine, in the eastern portion of the county, shipped some copper-bearing ore to the El Paso smelter. The Justice, at Perris, produced some gold with an arrastre. The Davis, at Barstow, Orange Blossom, at Amboy, and Sinbad, at Barstow, were small producers. Of the nonproducing operators developing their mines were the El Dorado Consolidated Mining Company, at Banning; the German American Mining Company, at Indio; and the Red Cloud Mining Company, at Mecca. The last has a 100-ton milling equipment. The mine is developed by 350-foot and 500-foot vertical shafts. The American Flag Gold Mining Company, at Paloverde, has a 7-stamp mill. A 3-mile pipe line has been put in.

COLORADO.

By Charles W. Henderson.

PRODUCTION.

The total value of the production of gold, silver, copper, lead, and zinc in Colorado for 1908, as reported from 667 productive mines, 43 of which were placers, amounted to $31,948,722. Of this, nearly 70 per cent represented the value of gold, which was $22,300,627, an increase of $1,474,433 as compared with the yield of 1907. The increase in value of gold was the only increase made, the combined decline in the value of the other metals overtopping the gold increase by $5,475,116. The increase in quantity of copper produced was offset by the low price of that metal in 1908, with the resultant decrease in value of $225,217. The quantity of lead produced in 1908 was 52,200,130 pounds, a decrease of 33,206,719 pounds. The quantity of zinc produced was 30,130,002 pounds, a decrease of 22,658,324 pounds.

The tonnage sold or treated in 1908 from Colorado mines was 2,243,891 short tons, a decrease of 139,237 tons as compared with the output in 1907.

The siliceous ore amounted to 1,830,930 tons, an increase of 139,284 tons. The average value of siliceous ore per ton in gold and silver was $13.10 in 1908, as compared with $14.49 in 1907 and with $14.90 in 1906.

The tonnage of copper ores was 12,347 short tons, a decrease of 10,272 tons. Lead ores amounted to 100,861 tons, a decrease of 209,739 tons. Zinc ores decreased from 17,748 tons in 1907 to 2,583 tons in 1908, a falling off of 15,165 tons. There were 58,236 tons of copper-lead ore produced in 1908, an increase of 50,395 tons. The tonnage of lead-zinc ores was 238,934 tons, a decrease of 93,740 tons.

The average value per ton of copper ores in gold and silver was $16.67; of lead ores, $11.58; of copper-lead ores, $16.94; and of lead-zinc ores, $2.01. The average total value per ton of all the ore mined in Colorado in 1908 was $14.16, as compared with $15.67 in 1907, with $16.47 in 1906, with $17.37 in 1905, and with $17.89 in 1904.

During 1908 there were treated at gold and silver mills of all kinds (including all the custom mills in the State), 1,338,801 tons, and the bullion saved amounted to $14,601,965 in gold, an average per ton of $10.91, and $173,565 in silver, an average per ton of 13 cents, a total value in gold and silver of $14,775,530, and a total average value of $11.04 per ton.

From the 1,338,801 tons treated at gold and silver mills, and from 373,378 tons sent to concentration and separation mills, a total to both classes of mills of 1,712,189 tons (76.3 per cent of the total tonnage treated), were produced 191,213 tons of concentrates, valued at $2,246,326 in gold, an average value per ton of $11.75, and $1,500,871 in silver, an average per ton of $7.85, a total in gold and silver of $3,747,197, and an average of $19.60 per ton.

There were produced from the 1,712,189 tons to both classes of mills, $16,848,291 in gold, from both bullion and concentrates, or an average recovery of $9.84, and $1,674,436 in silver, or an average recovery of 98 cents, a total in gold and silver of $18,522,727, and an average per ton of $10.82 for all ore milled. From re-treatment of

old tailings from Cripple Creek there were produced $412,000 in gold and 2,000 fine ounces of silver.

Crude ore shipped to all kinds of smelters amounted to 531,712 tons, and contained $4,855,401 in gold, averaging $9.13 per ton; $3,043,260 in silver, averaging $5.73 per ton, a total in gold and silver of $7,898,661, and an average of $14.86 per ton. The 191,213 tons of concentrates, valued at $2,246,326 in gold, and $1,500,871 in silver, were also shipped to the smelters. Crude ore and concentrates to smelters therefore amounted to 722,925 tons, valued at $7,101,727 in gold and $4,544,131 in silver, a total of $11,645,858 in gold and silver.

There were 43 productive placers in 1908 in Colorado, which yielded $184,935 in gold and $1,123 in silver, a total of $186,058 in gold and silver, an increase of $83,970 as compared with the placer yield of 1907.

The statement of Colorado production for 1907 and 1908, showing increase or decrease, and value at each year's average commercial price, is as follows:

Mine production of gold, silver, and associated metals in Colorado in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	1,007,467.14	$20,826,194	1,078,792.83	$22,300,627	+ 71,325.69	+$1,474,433
Silver.....do....	11,229,776	7,411,652	8,905,433	4,719,879	− 2,324,343	− 2,691,773
Copper.....pounds..	7,724,590	1,544,918	9,997,738	1,319,701	+ 2,273,148	− 225,217
Lead.....do....	85,406,849	4,526,563	52,200,130	2,192,405	−33,206,719	− 2,334,158
Zinc.....do....	52,788,326	3,114,511	30,130,002	1,416,110	−22,658,324	− 1,698,401
Total.....	.....	37,423,838	.....	31,948,722	.....	− 5,475,116

GOLD.

The total gold production for Colorado in 1908 amounted to 1,078,792.83 fine ounces, valued at $22,300,627, as against 1,007,467.14 fine ounces, valued at $20,826,194, in 1907, an increase of 71,325.69 fine ounces in quantity and of $1,474,433 in value.

The mining of gold ores, as compared with the mining of silver and base metal ores, was much more profitable in 1908 than in former years, because of the very low prices for the other metals. As a result there was an increased activity in the gold camps, or gold belts of the camps, with a general quietness in those camps whose ores carried chiefly the metals of fluctuating prices.

The Cripple Creek district, the ore of which is entirely gold, with a very small amount of silver, reaped the benefit of favorable rates from the mills, all of which were in position to treat a large tonnage. The increase of gold from this camp alone was $1,826,600.

Besides Teller County, the notable increases in gold production were in Clear Creek, Gilpin, and Lake counties, with less marked increases from Gunnison, San Juan, and Summit counties. The decrease in gold yield was particularly noticeable in the "San Juan" counties of La Plata, Ouray, and San Miguel. The decreases in Boulder, Chaffee, Hinsdale, and Park counties, added to those in the

three counties mentioned above, amounted to almost $1,000,000. The increases in the other counties added up to over $2,000,000.

Siliceous and dry ores, which made 82 per cent of all the tonnage mined, yielded 1,018,355.66 fine ounces of gold, valued at $21,051,280, or over 94 per cent of all the gold production. A little over 2 per cent of the gold came from copper-lead ores, and under 2 per cent from lead ores. There was a small amount of gold in copper and lead-zinc ores, but no gold in zinc ores.

Placer gold in 1908 amounted to 8,946.23 fine ounces, valued at $184,935. Summit County, with 3 dredges and several hydraulic and sluice mines, produced 79 per cent of the placer yield. One dredge operated in Routt County. Chaffee, Park, and San Miguel made up nearly all the remainder. Minor yields were reported from Clear Creek, Douglas, Eagle, and Gilpin counties.

Source of gold product in Colorado in 1908, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Siliceous or dry ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores	
Boulder		6,700.81	419.99	1.64				7,122.44
Chaffee	799.64	53.94	17.99	1,501.56				2,373.13
Clear Creek	126.26	30,369.04		1,021.44		319.43	48.57	31,884.74
Custer		334.76		12.72				347.48
Dolores		1,245.42	6.48	549.49				1,801.39
Douglas	6.34							6.34
Eagle	4.69	2,670.16	137.24					2,812.09
Fremont		4.40						4.40
Gilpin	18.43	49,340.21	2,174.17	509.40				52,042.21
Grand			25.98	.92				26.90
Gunnison		4,823.76	5.42	9.87				4,839.05
Hinsdale		35.02		48.91		34.78		118.71
Lake		[a] 26,969.74		9,439.80		22,943.68	73.00	59,426.22
La Plata		4,900.39						4,900.39
Mineral		64.87		1,257.80			4,437.00	5,759.67
Montezuma Rio Grande Routt, Saguache	235.01	97.08						332.09
Ouray		96,258.32	1,756.78	20.99		76.58	25.59	98,138.26
Park	583.69	20,176.82		77.59		2.23		20,840.33
Pitkin		24.53		1.50				26.03
San Juan		45,324.04	349.40	2,550.62		45.68		48,269.74
San Miguel	139.90	111,534.75	112.58	329.14				112,116.37
Summit	7,032.27	866.02		640.54		175.01	329.43	9,043.27
Teller		616,311.38						616,311.38
Unapportioned		250.20						250.20
	8,946.23	1,018,355.66	5,006.03	17,973.93		23,597.39	4,913.59	1,078,792.83

[a] Siliceous and dry. Iron-manganese oxide and iron sulphide.

SILVER.

The silver yield in 1908 amounted to 8,905,433 fine ounces, valued at $4,719,879, as against 11,229,776 ounces in 1907, valued at $7,411,652, a decrease of 2,324,343 ounces in quantity and of $2,691,773 in value.

Every county in the State except Dolores reduced its yield of silver. The largest decreases were in Lake, Pitkin, San Juan, Mineral, La Plata, and San Miguel, in the order named.

In the production of silver 7 counties, in the order named, Lake, San Miguel, Pitkin, San Juan, Mineral, Clear Creek, and Ouray, furnished 8,126,895 fine ounces, which represented 91 per cent of the total.

Siliceous ore yielded 5,553,591 fine ounces, or 62 per cent of the silver output; copper-lead ores yielded 941,394 ounces, or 11 per cent; lead ores, 1,501,803 ounces, or a little less than 17 per cent; lead-zinc ores 713,320 ounces, or 8 per cent; and copper ores 193,206 ounces, or a little more than 2 per cent.

Source of silver product in Colorado in 1908, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Siliceous or dry ores	Copper ores	Lead ores	Zinc ores	Copper-lead ores	Lead-zinc ores.	
Boulder	.....	21,185	.....	313	.....	.....	.....	21,498
Chaffee	158	1,455	4,504	29,628	.....	.....	.....	35,745
Clear Creek	95	334,783	.....	142,073	.....	2,470	24,130	503,551
Custer	.....	9,183	.....	3,973	.....	.....	.....	13,156
Dolores	.....	82,782	66	80,715	.....	.....	.....	163,563
Douglas	.....	.....	.....	.....	.....	.....	.....	.....
Eagle	.....	62,987	14,294	9,434	.....	.....	.....	86,715
Fremont	.....	4	.....	.....	.....	.....	.....	4
Gilpin	4	149,019	8,320	29,687	.....	.....	.....	187,030
Grand	.....	.....	11	61	.....	.....	.....	72
Gunnison	.....	14,904	2,000	11,760	.....	.....	.....	28,664
Hinsdale	.....	6,007	.....	4,925	.....	18,566	.....	29,498
Lake	.....	[a]1,712,577	.....	137,498	.....	897,480	145,941	2,893,496
La Plata	.....	71,487	.....	.....	.....	.....	.....	71,487
Mineral	.....	117,376	.....	531,147	.....	.....	77,079	725,602
Montezuma	}							
Rio Grande	} 34	1,934	2	330	.....	.....	.....	2,300
Routt, Saguache	}							
Ouray	.....	328,968	66,408	6,179	.....	13,515	.....	415,070
Park	123	11,016	.....	308	.....	600	.....	12,047
Pitkin	.....	530,928	.....	72,708	.....	.....	438,064	1,041,700
San Juan	.....	578,273	84,642	333,181	.....	8,191	.....	1,004,287
San Miguel	67	1,435,197	40	107,883	.....	.....	.....	1,543,187
Summit	1,638	22,790	12,919	.....	.....	572	28,106	66,025
Teller	.....	60,736	.....	.....	.....	.....	.....	60,736
	2,119	5,553,591	193,206	1,501,803	.....	941,394	713,320	8,905,433

[a] Siliceous and dry. Iron-manganese oxide and iron sulphide.

COPPER.

The copper output increased in quantity from 7,724,590 pounds in 1907 to 9,997,738 pounds in 1908, but decreased in value by $225,217.

As usual, Lake County was the leading copper producer, yielding 47 per cent of the total in 1908; San Juan County was second, with 23 per cent of the total; Ouray was the third copper-yielding county, Gilpin, San Miguel, Chaffee, Clear Creek, and Hinsdale following in order. These 8 counties produced 9,787,083 pounds, or almost 98 per cent of the total.

Copper was reported from 17 counties in Colorado. The smelter output reached 13,943,878 pounds, which was 3,946,140 pounds above the yield reported by the mines. This difference can be accounted for chiefly by the fact that copper occurs in the ores of many mines in quantity less than 1.5 per cent by assay, which is not paid for by the smelters and consequently not reported by the miners.

LEAD.

The lead produced in Colorado in 1908 was 52,200,130 pounds, valued at $2,192,405, as against 85,406,849 pounds, valued at $4,526,563, in 1907, a decrease of 33,206,719 pounds in quantity

and of $2,334,158 in value. There were very large decreases in yield from Lake, Mineral, Pitkin, San Juan, Hinsdale, Clear Creek, and Park counties. Eagle, Gilpin, and Summit counties also showed a decrease. Dolores County made a notable increase, as did Chaffee County. Other increases were in Boulder, Custer, Gunnison, and San Miguel counties.

In rank Lake County led, with a margin of over 11,000,000 pounds, San Juan County was second, and Pitkin, San Miguel, Clear Creek, Mineral, Summit, Ouray, Chaffee, and Dolores counties followed in order.

There was a decrease of 303,479 short tons of the combined tonnage of lead and lead-zinc ores, as compared with the totals of 1907. The largest decline in these classes of ore was in Lake, Mineral, and Pitkin counties.

ZINC.

The mine production of zinc in 1908 amounted to only 57 per cent of the output of 1907. In 1908, there were produced 30,130,002 pounds, valued at $1,416,110, a decrease of 22,658,324 pounds in quantity and of $1,698,401 in value.

The figures above illustrate the condition of the zinc mines in Colorado in 1908. In Lake County, which produced 77 per cent of the State zinc total, the zinc yield fell from 37,412,374 pounds in 1907 to 23,188,080 pounds in 1908, a decrease of 14,224,294 pounds. The output in Pitkin County fell from 5,799,746 pounds to 722,362 pounds, a decrease of 5,077,384 pounds. In Lake County 2 large zinc-producing mines were closed during 1908. One large company continued to mine zinc ore throughout the year, but stored a large tonnage for sale or treatment at some later date. The low price of zinc in 1908 was met by a curtailment of operations in Chaffee, Clear Creek, Eagle, Mineral, Ouray, and San Juan counties. Increases were made in Dolores, Gunnison, Park, and San Miguel counties.

The production of spelter in Colorado in 1908, as actually produced by the smelters, was 49,770,000 pounds. The mine figures for spelter contained in the ore sold or treated in 1908 was, as given above, 30,130,002 pounds. This estimate is made by considering each individual shipment separately and allowing a loss of from 20 to 36 per cent of the assay percentage of the zinc in the ore, depending on the treatment necessary to extract the zinc; that is, ore that was smelted in the crude suffered the loss of but one operation, while ore of lower assay value which had to be first concentrated and then smelted suffered the mechanical loss of separation or concentration, and also the metallurgical loss in smelting. The wide difference in the two sets of figures is largely due to the fact that the smelter stock on hand at the beginning and the end of a year is seldom a constant quantity. In the case of the zinc smelters of Colorado, there was a wide difference between the stock on hand on January 1, 1908, and on December 31, 1908. Figures from two large zinc companies in Colorado show a large stock of ore on hand at the beginning of 1908. But as the mines closed down or stored their zinc ores, the smelters were forced to draw heavily on the stock, with the result that during a greater part of the year they were running entirely on stock ore.

These figures as to the quantity of spelter in the stock ore reconcile the apparent discrepancy as to spelter production.

COLORADO ZINC MILLS.

The plant of the Empire Zinc Company, located at Canon City, about 1½ miles from the pigment works of the United Smelting Company, treats sulphide ores containing zinc, lead, and iron, making lead concentrates, lead-iron or iron concentrates, and zinc concentrates. It consists of a wet mill employing jig and table concentration, and a dry mill in which are used 11 Wetherill magnetic separators.

The plant of the Western Chemical Company, at Denver, comprises the following departments: sampling, or coarse crushing mill, driers, fine crushing mill, roasters, magnetic separating mill, and wet concentration mill. The magnetic separating mill contains 1 Cleveland-Knowles, and 1 type E 2-pole Wetherill separator. This plant, in 1908, treated all milling zinc ores, including middlings and low-grade zinc concentrates from other mills.

At Leadville, the mill of the American Zinc Extraction Company uses the International magnetic separator. This mill was in steady operation in 1908 on ore from the Yak Tunnel Company, from the Moyer dump, and on other custom ore. The Adams mill and the A. Y. and Minnie mill, at Leadville, are wet-milling plants.

At Rico the Pro Patria mill (part of which was destroyed by fire in 1908) is both a wet-jig and table-concentration plant and a dry-magnetic separating plant.

The United Zinc Company's works at Pueblo comprise a zinc separating plant equipped with magnetic machines of the mechanical pattern, as well as zinc retorts, which are a modification of the Belgian-Silesian type.

The Wilfley plant at Kokomo is prepared to use the Wetherill magnetic separator, and has several Wilfley tables in addition.

The Colorado Zinc Company's plant, in Denver, is a dry magnetic separator of the Wetherill type.

COLORADO SMELTING PLANTS.

The following list gives the smelting plants in Colorado in 1908:

List of active Colorado smelting plants in 1908.

City.	Plant.	Owner.
Denver	Globe	American Smelting and Refining Co.
Pueblo	Pueblo	Do.
Pueblo	Eilers	Do.
Pueblo[a]	United States Zinc Co.	Do.
Leadville	Arkansas Valley	Do.
Durango	Durango	Do.
Denver	Argo	Boston and Colorado Smelting and Refining Co.
Canon City		United States Smelting Co.
Salida		Ohio and Colorado Smelting and Refining Co.

[a] Zinc-copper ores.

MINING INDUSTRY OF COLORADO IN 1908.

The year's figures for Colorado showed an increase of $1,474,433 in value of gold, but the total value of gold, silver, copper, lead, and zinc decreased $5,475,116. The quantity of copper produced (chiefly from copper-lead ores, and dry ores carrying substantial values in gold and silver), showed a creditable increase, though the total value of the copper yield showed a decline. Both placers and auriferous lode mines increased their yield.

The feature of the operations of the precious-metal mines of this State in 1908 was a further extension of the leasing system in the camps of Cripple Creek, Central City, Idaho Springs, Ouray, Silverton, and Telluride. Because of the low metal prices during the latter part of 1907 and throughout 1908, the operations of the silver-lead-zinc camps were greatly curtailed. The miners from the base-metal camps turned their attention to the gold camps, and took up leases which would not have been acceptable in times of high base-metal prices, or devoted their time to prospecting. By the beginning of 1908 an increased tonnage of gold ores was being sent to the mills and smelters by lessees.

At Cripple Creek there was an influx of skilled miners. Leases were taken on many old and well-developed properties, and also on the big dumps of the camp. Experiments as to treating the low-grade ore and dump ore by cyanide treatment resulted in the building and remodeling of several local plants, and a decided impetus was given to small operators by reductions in freight and treatment charges at three different times during the year. Work on the Roosevelt drainage tunnel progressed steadily throughout the year, with an aggregate of 4,872 feet completed of the total of 15,500 feet.

In Clear Creek County the operating companies were occupied in connecting their shafts with the Newhouse tunnel, which has been driven about 17,000 feet from the portal at Idaho Springs. Many companies completed their laterals to the Newhouse tunnel early in the year, and a gradually increasing tonnage has found its way out through this tunnel.

After two years' delay, pending the ratification of contracts with the mine operators of Gilpin County, work was resumed on the heading of the Newhouse tunnel in December, 1908, and the tunnel will be extended to Quartz Hill, cutting the Gilpin County mines at a depth of 1,550 feet. The development work started in 1907 was carried on in 1908.

The production of Leadville (Lake County) fell off greatly. Several of the largest properties were closed the entire year, but two resumed operations in December, 1908. The zinc-ore production of this camp, which was 71 per cent of the entire output of such ores in the State in 1907, also fell off greatly. The Yak tunnel reached a point about 3 miles from the portal in December. During the last two months there was more activity in the camp than at any other time in the year.

The production from the San Juan country did not vary much from that of 1907.

In Summit County 2 new dredges were operated from June to the close of the year, and their output materially increased the gold production from this county.

Pitkin County (Aspen) continued to decrease its silver and lead production, as did Mineral County (Creede).

The completion and extension of electric power facilities in Boulder, Clear Creek, Gilpin, Lake, and Summit counties resulted in a more general use of this power in the mining camps of these counties. The dredges of Summit County, near Breckenridge, were supplied by the Summit County Power Company. The power plant at the mouth of the Yak tunnel, in Leadville, furnished power not only to the Yak enterprise, but also to the American Zinc Extraction Company's zinc mill, to the city of Leadville, and to the remainder of the district. The United Rico Mines Company, at Rico, Dolores County, has its own electric power plant. Electricity from Canon City was used in Cripple Creek for lighting and power. In San Juan, electric plants have been in operation for some time in the counties of Ouray, San Juan, and San Miguel.

The following table shows the production of gold, silver, and associated metals in Colorado, by counties:

Mine production of gold, silver, copper, lead, and zinc in 1908, in Colorado, by counties.

County.	Producing mines.	Tonnage of deep mines.	Gold.		Silver.	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Boulder	38	10,296	7,122.44	$147,234	21,498	$11,394
Chaffee	16	8,772	2,373.13	49,057	35,745	18,945
Clear Creek	104	109,672	31,884.74	659,116	503,551	266,882
Custer	7	3,700	347.48	7,183	13,156	6,973
Dolores	5	11,024	1,801.39	37,238	163,563	86,688
Douglas	2	.....	6.34	131	.....	.....
Eagle	10	3,009	2,812.09	58,131	86,715	45,959
Fremont	2	26	4.40	91	4	2
Gilpin	112	120,761	52,042.21	1,075,808	187,030	99,126
Grand	2	14	26.90	556	72	38
Gunnison	16	14,439	4,839.05	100,032	28,664	15,192
Hinsdale	10	980	118.71	2,454	29,498	15,634
Lake	61	408,711	59,426.22	1,228,449	2,893,496	1,533,553
La Plata	9	2,408	4,900.39	101,300	71,487	37,888
Mineral	7	61,131	5,759.67	119,063	725,602	384,569
Montezuma, Rio Grande, Saguache	7	93	80.20	1,658	1,058	561
Ouray	21	96,493	98,138.26	2,028,698	415,070	219,987
Park	20	11,372	20,840.33	430,808	12,047	6,385
Pitkin	18	133,408	26.03	538	1,041,700	552,101
Routt	8	4	251.89	5,207	1,242	658
San Juan	42	202,643	48,269.74	997,824	1,004,287	532,272
San Miguel	26	428,231	112,116.37	2,317,651	1,543,187	817,889
Summit	28	14,631	9,043.27	186,941	66,025	34,993
Teller	96	601,173	616,311.38	12,740,287	60,736	32,190
Unapportioned	.....	900	250.20	5,172	.....	.....
	667	2,243,891	1,078,792.83	22,300,627	8,905,433	4,719,879

Mine production of gold, silver, copper, lead, and zinc in 1908, in Colorado, by counties—Continued.

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Boulder	28,955	$3,822	96,503	$4,053			$166,503
Chaffee	337,804	44,590	1,040,238	43,690	703,706	$33,074	189,356
Clear Creek	264,994	34,979	2,015,010	84,630	836,411	39,311	1,084,918
Custer	243	32	120,330	5,054			19,242
Dolores	42,495	5,609	947,962	39,814	509,184	23,932	193,281
Douglas							131
Eagle	66,141	8,731	11,204	471			113,292
Fremont							93
Gilpin	636,371	84,001	538,143	22,602			1,281,537
Grand	1,561	206	690	29			829
Gunnison	5,481	724	327,612	13,760	147,000	6,909	136,617
Hinsdale	188,698	24,908	280,465	11,780			54,776
Lake	4,674,502	617,034	19,646,007	825,132	23,188,080	1,089,840	5,294,008
La Plata							139,188
Mineral			1,731,987	72,743	1,100,107	51,705	628,080
Montezuma, Rio Grande, Saguache	150	20	27,715	1,164			3,403
Ouray	1,019,574	134,584	1,675,411	70,367			2,453,636
Park	37,106	4,898	495,985	20,831	728,000	34,216	497,138
Pitkin			7,568,060	317,859	722,362	33,951	904,449
Routt							5,865
San Juan	2,282,738	301,321	8,402,569	352,908	10,131	476	2,184,801
San Miguel	382,402	50,477	5,555,049	233,312	952,872	44,785	3,464,114
Summit	28,523	3,765	1,719,190	72,206	1,232,149	57,911	355,816
Teller							12,772,477
Unapportioned							5,172
	9,997,738	1,319,701	52,200,130	2,192,405	30,130,002	1,416,110	31,948,722

The total tonnage, by kinds of ore treated or sold in each county in 1908, is shown in the following table:

Subdivision of crude ore sold or treated in Colorado in 1908, by counties, in short tons.

County.	Siliceous or dry ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Lead-zinc ores.	Total.
Boulder	10,068	120	108				10,296
Chaffee	53	3,284	4,285	1,150			8,772
Clear Creek	92,592		5,229		198	11,653	109,672
Custer	3,256		444				3,700
Dolores	3,684	18	7,322				11,024
Douglas							
Eagle	2,384	550	75				3,009
Fremont	26						26
Gilpin	117,014	1,329	2,418				120,761
Grand		10	4				14
Gunnison	13,410	58	971				14,439
Hinsdale	40		586		354		980
Lake	[a] 232,657		24,616		56,132	95,306	408,711
La Plata	2,408						2,408
Mineral	4,409		20,581			36,141	61,131
Montezuma, Rio Grande, Routt, Saguache	63	1		33			97
Ouray	90,741	4,715	248		768	21	96,493
Park	9,920		42	1,400	10		11,372
Pitkin	42,228		4,255			86,925	133,408
San Juan	180,487	2,149	19,513		494		202,643
San Miguel	419,947	113	8,171				428,231
Summit	3,470		1,993		280	8,888	14,631
Teller	601,173						601,173
Unapportioned	900						900
Total	1,830,930	12,347	100,861	2,583	58,236	238,934	2,243,891
Average recovered value in gold and silver per ton	$13.10	$16.67	$11.58		$16.94	$2.01	$11.98

[a] Siliceous and dry. Iron-manganese oxide and iron sulphide.

The tonnage of ore sold or treated, number of deep mines producing, and average value per ton of ore reported by deep mines in Colorado in 1907 and 1908, by counties, is shown in the following table:

Tonnage of ore sold or treated, number of deep mines producing, and average total value per ton of ore reported by deep mines in Colorado in 1907 and 1908, by counties.

County.	Total tons of ore sold or treated.		Number of deep mines producing.	
	1908.	Increase (+) or decrease (−).	1907.	1908.
	Short tons.	*Short tons.*		
Boulder	10,296	+ 2,296	38	38
Chaffee	8,772	− 5,820	11	13
Clear Creek	109,672	+ 30,124	85	95
Custer	3,700	+ 2,099	8	7
Dolores	11,024	+ 9,449	8	5
Eagle	3,009	− 1,182	14	8
Fremont	26	− 136	4	2
Gilpin	120,761	+ 32,874	78	110
Grand	14	+ 14	.....	2
Gunnison	14,439	− 3,639	17	16
Hinsdale	980	− 9,760	9	10
Huerfano	.....	− 3	1	.....
Jefferson	.....	− 18	2	.....
Lake	408,711	−222,562	64	61
La Plata	2,408	− 5,381	7	9
Mineral	61,131	− 43,846	10	7
Montezuma, Rio Grande, Routt, Saguache	97	− 99	8	8
Ouray	96,493	− 169	25	21
Park	11,372	− 1,289	16	13
Pitkin	133,408	− 50,428	20	18
San Juan	202,643	− 32,996	27	42
San Miguel	428,231	+ 20,740	27	25
Summit	14,631	− 10,496	29	18
Teller	601,173	+150,091	83	96
Unapportioned	900	+ 900	.....	.....
Total	2,243,891	−139,237	591	624
Average value per ton	.....	.....	$15.67	$14.16

The following table shows the number of producing mines in Colorado, classified by chief product, in 1908, by counties:

Number of producing mines in Colorado in 1908, classified by chief product, by counties.

County.	Gold placer mines.			Deep mines.															Total mines producing.
	Hydraulic.	Surface.	Dredge.	Gold.	Silver.	Copper.	Lead.	Zinc.	Gold-silver.	Gold-silver-copper.	Gold-silver-lead.	Gold-copper.	Gold-lead.	Silver-copper.	Silver-copper-lead.	Silver-lead.	Silver-lead-zinc.	Lead-zinc.	
Boulder	....	....	....	32	1	....	1	....	3	....	....	....	....	1	....	....	....	....	38
Chaffee	1	2	....	2	1	3	3	....	1	....	....	....	....	....	....	2	....	1	16
Clear Creek	....	9	....	29	18	....	1	2	37	....	1	....	1	....	....	3	2	1	104
Custer	....	....	....	....	5	....	1	....	1	....	....	....	....	....	....	....	....	....	7
Dolores	....	....	....	....	1	1	....	....	1	....	....	....	....	....	....	1	1	....	5
Douglas	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Eagle	....	2	....	4	2	....	....	....	1	....	....	....	....	1	....	....	....	....	10
Fremont	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Gilpin	....	2	....	99	....	2	1	....	2	....	1	3	....	....	....	2	....	....	112
Grand	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	1	....	....	2
Gunnison	....	....	....	8	4	....	1	....	1	....	....	....	....	....	....	1	1	....	16
Hinsdale	....	....	....	1	3	1	4	....	....	....	....	....	....	....	....	1	....	....	10
Lake	....	....	....	9	22	....	5	3	5	3	2	....	1	....	....	8	....	3	61
La Plata	....	....	....	6	....	....	....	....	3	....	....	....	....	....	....	....	....	....	9
Mineral	....	....	....	....	5	....	....	....	1	....	....	....	....	....	....	....	1	....	7
Montezuma																			
Rio Grande	2	4	1	4	....	2	....	1	1	....	....	....	....	....	....	....	....	....	15
Routt																			
Saguache																			
Ouray	....	....	....	6	4	3	1	....	6	....	....	....	....	....	1	....	....	....	21
Park	1	6	....	8	3	....	....	1	....	....	....	1	....	....	....	....	....	....	20
Pitkin	....	....	....	1	12	....	1	....	....	....	....	....	....	....	....	4	....	....	18
San Juan	....	....	....	14	8	2	9	....	2	1	....	1	....	1	2	2	....	....	42
San Miguel	....	1	....	12	1	....	2	....	4	....	2	....	1	....	....	3	....	....	26
Summit	2	6	2	3	2	....	5	....	3	....	1	1	....	....	....	1	....	2	28
Teller	....	....	....	96	....	....	....	....	....	....	....	....	....	....	....	....	....	....	96
	6	34	3	335	93	14	35	7	72	4	7	7	3	3	3	29	5	7	667

REVIEW BY COUNTIES.

BOULDER COUNTY.

The total value of the metallic production from Boulder County in 1908 decreased $16,094 from that of 1907. The production was $147,234 in gold, 21,498 fine ounces of silver, 28,955 pounds of copper, and 96,503 pounds of lead. The quantity of both lead and copper was greater in 1908 than in 1907.

The number of mines producing was 38, the same as in 1907. The tonnage, 10,296 tons, was 2,296 tons above that of 1907. The average value per ton of ore dropped from $22.82 in 1907 to $16.17 in 1908. Of this value per ton in 1908 there was $14.30 in gold and $1.11 in silver.

The greater part of the ore in Boulder County is treated in stamp amalgamation mills, with and without cyanide plants. The average recovery in bullion in 1908 was $4.84 per ton in gold and 30 cents in silver, a total of $5.14. Concentrates produced both at amalgamation mills with concentrators and at mills for concentration only averaged $19.02 per ton in gold and $6.68 in silver, a total in gold and silver of $25.70. The total average recovery per ton in bullion and concentrates showed the average of all milling ore to be $5.66 in gold and 63 cents in silver, a total in gold and silver of $6.29 per ton.

The average value per ton of the smelting ore of Boulder County was $49.30 in gold and $3.04 in silver, a total in gold and silver of $52.34 per ton. In Boulder County there is always much ore from "pockets" that runs high in gold, some of which is made into crude bullion at the mine. Some "picked ore" of high value is shipped in sacks to the smelters.

Central district.—The production of gold from this district was three-fourths of the yield of 1907. A car or two of gold ore was shipped by the Longfellow Consolidated Mines Company. At the 125-ton cyanide mill, with a 40-ton roaster, of the Monarch Consolidated Company, only ore from the Wano group was milled. The company also reported development work on the Pilot group. Lessees on the Smuggler took out a little ore in 1908. Some high-grade samples were taken out of the Rip Van Dam mine.

Gold Hill district.—This district, the foremost in production of the county, made an increased output in 1908. The value of gold amounted to $59,094; the total value of gold, silver, and lead was $69,113. The tonnage from 9 mines in 1908 was 5,218 short tons, as compared with 1,040 tons from 14 mines in 1907. The mines of the Ingram Mining and Milling Company, the Black Cloud mine of the Pollock Mining and Milling Company, and the Slide mine were the most prominent in the district. The shaft on the Slide mine is 1,000 feet deep. The Pollock company has a 20-stamp amalgamation and concentration mill, which was completed in 1908. The Charity Mining Company operated the Golden Eagle mine during the greater part of the year. The shaft on the mine is down 480 feet, and there is an adit 2,500 feet long. A little high-grade ore was shipped from the Sun and Moon mine and several cars of gold ore were shipped from the Cash Birkin mine. Lessees on the Inter-Ocean mine shipped some ore in 1908; the shaft is now 600 feet deep; the plant on the property is a 50-ton concentration mill. A few shipments were made from the Parallel mine and from the Lottie mine.

Grand Island district.—There was a slight increase reported from this district, from near Caribou, Cardinal, Eldora, and Sunset. The total value of the metallic yield in 1908 was $7,028, from 4 mines. The Cashier Mining and Milling Company completed its 60-ton concentration mill late in the fall of 1908 and shipped concentrates to Denver. The Albion mine of this company is opened by an adit 700 feet long. Some high-grade gold ore was shipped from the Revenge mine. The shaft on the property was sunk to the 500-foot level. The mine was closed in May, 1908, until drainage can be obtained by the extension of the Highland Mary tunnel. Some silver ore was shipped by the Pine Grove Mining and Milling Company. The lessee on the St. Louis mine ran the mill for a time, the concentrate produced being chiefly valuable in gold.

The Highland Mary company reported 1,100 feet completed on the company's tunnel. The Denver Transportation and Drainage Tunnel reported 1,200 feet now driven. The Consolidated Copper Company reported a tunnel now 4,200 feet long and a shaft 360 feet deep.

Magnolia district.—The Cash mine was idle in 1908. The mine of the India Gold Mining Company is opened by an adit 1,800 feet long and a shaft 350 feet deep. This company made no production in 1908.

Sugar Loaf district.—There was an increased tonnage sold or treated in this district in 1908, but the value of the output decreased. The total production was valued at $26,757. The Annuity Mining and Reduction Company shipped gold-copper ores to Argo from the Dolly Varden mine. The Clinton Mining and Milling Company, operating the Logan mine, reduced some of its high-grade ore in a small laboratory plant, and shipped the rest to smelters. A small production was made from the Five Points mine. The Good Luck Mining and Milling Company operated its 35-ton cyanide plant during the last six months of 1908. Some ore was shipped from the Triangle mine. The Milwaukee and Colorado Gold Mining Company, operating the Dime mine, made a nominal production. The 5-stamp mill of the Signal Mining and Milling Company was operated three months on ore from the Gladys mine.

The United States Gold Corporation has driven an adit 1,500 feet long and has completed a 150-ton cyanide plant. During 1908, a cyanide plant at Wallstreet was run for several weeks on old tailings from the company's property.

Ward district.—The decrease in the Boulder County production was mainly due to the falling off in the yield of the Ward district. This district, which produced $43,286 in 1907, produced $26,559 in 1908. The output from the Big Five Company was not so large as in 1907. The tunnel is 9,000 feet long. The mines of the Columbia Lode Mining Company, the Poorman mine, and the Golden Queen mine were operated part of the year. Other productive mines were the Celestial Extension, Texas, Morning Star, Utica Hill group, and Ward Rose.

CHAFFEE COUNTY.

Mine production of gold, silver, and associated metals in Chaffee County, Colo., in 190[7] and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	3,645.73	$75,364	2,373.13	$49,057	− 1,272.60	−$26,3[0]
Silver.....do....	38,465	25,387	35,745	18,945	− 2,720	− 6,4[4]
Copper.....pounds..	799,505	159,901	337,804	44,590	− 461,701	−115,3[11]
Lead.....do....	630,623	33,423	1,040,238	43,690	+ 409,615	+ 10,2[67]
Zinc.....do....	2,091,489	123,398	703,706	33,074	−1,387,783	− 90,3[24]
	.....	417,473	.....	189,356	.....	−228,1[17]

In Chaffee County the value of the total metallic output in 190[8] showed a decrease of over one-half the value of the yield in 1907. Th[e] tonnage treated in 1907 was 14,592 short tons; in 1908 it was 8,772, [a] reduction for 1908 of 5,820 short tons.

There were 11 productive deep mines and 3 placers. The placer[s] of the county yielded $16,530 in gold, as against $35,373 in 190[7]. Thus, the decrease in the county's gold production was chiefly in th[e] placer output. The decrease in the copper yield was caused by a les[s]ened output from the Turret district. Smaller shipments of zinc o[re] from Monarch account for the zinc decrease. An increased tonna[ge] of lead ore from the last named district resulted in an increase of lea[d] production for the county.

There were 1,500 tons of ore treated in gold and silver mills, and 7,272 tons were shipped to smelters.

Chalk Creek district.—The only producer in this district in 1908 was the J. A. J. Milling Company, operating the Mary Murphy mine. The milling ore was treated in the Pawnee mill, which is equipped with 20 stamps, plates, and Wilfley tables. The product was in bullion and lead and zinc concentrates. Some lead ore was shipped direct to the smelter. The Flora Bell Mining Company was engaged in development work. The mine is opened by a 100-foot incline shaft. About 850 feet were driven in 1908 on a crosscut tunnel.

Cleora district.—Development work only was reported in this district.

Granite district.—This district produces all the placer gold in the county. There were 3 placer producers, and a reduced output in 1908. The Clear Creek Leasing Company, working the Twin Lakes placer by hydraulicking, was the principal producer. A small shipment of ore containing gold and lead was made from the Margaret lode mine. The Granite Tunnel Company, organized in 1908, drove 350 feet of tunnel during the year. The proposed tunnel is to be 3,000 feet long, and will cut many of the old veins around Granite below any previous workings.

La Plata district.—The Waverly Consolidated Mining Company shipped a small tonnage of ore, carrying principal values in silver. The Banker Mining and Tunnel Company drove 1,200 feet in 1908. The tunnel is now 3,200 feet in length.

Monarch district.—This, the principal district in Chaffee County, showed a small increase in 1908 over the output of 1907, in gold and silver values, but a heavy decrease in the production of copper, lead, and zinc. The values of gold and silver, however, constitute but one-sixth of the total value of the metallic output.

There were 7 shippers in the district. The Monarch-Madonna mine continued to lead in production. The lead-silver ore was smelted in Colorado. The zinc ore, of good grade, which occurs as a silicate and carbonate envelope about the lead-silver ore bodies, was shipped to middle western smelters. A new tunnel was started 450 feet below the lowest level and driven 650 feet in 1908. A large body of smelting ore is reported blocked out, ready for shipment in 1909. The Taylor Mountain Mining Company shipped some copper ore during 1908. The mine is developed by a shaft 368 feet deep, a tunnel 2,500 feet long, and a winze 212 feet deep below the tunnel level. An aerial tramway, 7,175 feet long, transports the ore from the mine to the ore bins. The Vega Consolidated Mining Company shipped considerable lead-silver ore. The mine is developed by a tunnel 1,500 feet long, and in 1909 a large body of lead-silver ore was reported. Lead-silver ore was shipped by the Garfield Mining, Milling and Smelting Company, whose mine is opened by a tunnel 2,000 feet long. Trial shipments of lead-silver ore were made during the year from the Last Chance and Little Orphan mines.

Riverside district.—Several cars of lead-silver ore, with values in gold, were shipped from the Harvard tunnel property.

Turret district (including Sedalia).—The Sedalia Copper mine, in this district, was operated under lease during 1908. All the ore was from old stopes and dumps. The Florence Mining and Leasing Company, at Turret, was also a producer of copper ore. The Independence mine was not worked.

CLEAR CREEK COUNTY.

Mine production of gold, silver, and associated metals in Clear Creek County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	25,295.09	$522,896	31,884.74	$659,116	+6,589.65	+$136,220
Silver.....do....	518,364	342,120	503,551	266,882	− 14,813	− 75,238
Copper.....pounds..	171,340	34,268	264,994	34,979	+ 93,654	+ 711
Lead.....do....	2,804,172	148,621	2,015,010	84,630	− 789,162	− 63,991
Zinc.....do....	1,406,187	82,965	836,411	39,311	− 569,776	− 43,654
	.....	1,130,870	.....	1,084,918	.....	− 45,952

The increase in gold and copper output in Clear Creek County, in 1908 as compared with that of 1907, and the falling off in silver, lead, and zinc, showed a net decrease of $45,952 in value for the year. The reason for this is that the silver-lead-zinc mines of Upper Clear Creek, which did not carry gold in their ores, were idle, or were worked with a reduced force in 1908, while the Lower Clear Creek mines, the most of which are classed as gold or gold-silver mines, with siliceous ore, could be operated at a profit, either on company account or by lessees; and the number of the latter was greatly increased by the exodus from the silver-lead camps from all over the State.

There were 104 producing mines in 1908, as compared with 85 in 1907, an increase of 19; and the tonnage produced in 1908 was 109,672 short tons, as against 79,548 tons in 1907, an increase of 30,124 tons. The average total value per ton, however, fell to $9.87, as compared with $14.07 in 1907, and with $20.14 in 1906.

The output of gold and silver from placers decreased. From all other sources the gold increased, and silver increased from all kinds of ore, except siliceous ore.

The average value per ton of siliceous ore in gold and silver was $8.70, of which $6.78 was gold; of copper-lead ores, $39.96, of which $33.35 was gold; of lead ores, $18.44, of which $4.04 was gold; and of lead-zinc ores, $1.18, of which $0.08 was gold.

During 1908 there were treated at the stamp amalgamating mills in Idaho Springs and Black Hawk 27,428 short tons of ore, and the bullion saved on the plates amounted to $36,666 in gold, an average of $1.34 per ton, and $652 in silver, an average of $0.02 per ton, a total value of gold and silver of $37,318, and an average value of $1.36 per ton. From this ore and from 66,587 tons sent to mills for concentration only—a total to both classes of mills of 94,015 tons, or 85.7 per cent of all tonnage produced—there were produced 14,550 tons of concentrates, valued at $368,095 in gold, an average of $25.30 per ton, and $89,055 in silver, an average of $6.12 per ton, a total in gold and silver of $457,150, and a total of $31.42 per ton.

There were produced from the ore to both classes of mills $404,761 in gold, from both bullion and concentrates, or an average of $4.31 per ton, and $89,707 in silver, or a total average in gold and silver of $5.26 per ton for all milling ore.

Crude ore shipped to smelters amounted to 15,657 tons, which contained $251,745 in gold, averaging $16.08 per ton, and $177,125 in silver, averaging $11.31 per ton—a total in gold and silver of $428,870, and an average value of $27.39 per ton.

The average value in gold, silver, copper, lead, and zinc of the entire tonnage mined was $9.87, of which $5.99 was for gold, $2.43 for silver, $0.32 for copper, $0.77 for lead, and $0.36 for zinc.

In Clear Creek County the operating companies near Idaho Springs were occupied in connecting their shafts with the Newhouse tunnel. This tunnel starts at Idaho Springs at an elevation of about 7,543 feet, and cuts about 1,500 feet below the Clear Creek-Gilpin ridge. In 1907 it had been driven 17,000 feet from the portal. Many companies completed their laterals to the tunnel in the early part of the year, and a gradually increased tonnage found its way out to the railroad and the mills. There was an increase in the number of leases taken in the Idaho Springs district. The low prices for silver and the base metals were seriously felt in the other districts of the county.

Argentine district.—In the Argentine district, with the same number of producing mines as in 1907, the production in 1908 was valued at $57,337, a decrease of $21,612. The value of gold was about the same as in 1907; the quantity of copper increased threefold; the values of silver and lead were one-half of those in 1907; and the quantity of zinc was one-tenth of the output of 1907.

The Santiago Consolidated Mining, Milling and Tunnel Company was the largest producer in the district. The company's 40-ton concentrating mill was not operated in 1908, and all ore was sent to smelters. Some high-grade crude zinc ore was sent direct to the zinc smelters. The East Argentine Mining Company, operating the Sydney tunnel, made a slightly increased production from crude ore and concentrates. The Waldorf Consolidated Mining Company shipped but little ore in 1908 because of the low prices of metals. The greater part of the Waldorf production was from concentrates from the company's concentration mill. A small tonnage was shipped from the Josephine mine during the last month of 1908. The Manhattan Union Mining Company, the second largest producer in the district in 1907, was idle in 1908. The McClellan Mining, Milling and Tunnel Company was occupied for several months in driving the Scott tunnel, which is to cut the veins on McClellan Mountain at a depth of 800 to 1,200 feet.

Griffith district.—The total value of the production of deep mines in the Griffith district fell from $300,434 in 1907 to $203,190 in 1908. There were 15 producing mines in 1908 and 18 in 1907. There was an increase of 16,553 tons of ore produced, and of $28,689 in gold. The quantity of silver produced fell from 149,927 fine ounces in 1907 to 138,523 fine ounces in 1908; of copper, from 8,370 pounds to 683 pounds; of lead, from 1,927,925 pounds to 844,716 pounds; and of zinc from 1,196,983 pounds to 819,366 pounds. This district produced 98 per cent of all the zinc produced in the county.

The Capital Mining and Milling Company operated its mill from March, 1908, throughout the year, and treated a large tonnage of ore. The chief value of the ore is in gold, with considerable lead and silver in the concentrates. The equipment of the mills consists of crushers, rolls, two 6-foot Chilian mills, amalgamating plates, card concentrat-

ing tables, and slime tables; the slime overflow goes to canvas tables. The Frostburg-Mendota mine, operated by lessees, was the largest producer of lead and zinc in the district, and also yields gold and silver. The mill plant consists of a 40-ton jig concentrator. The Dives-Pelican and Seven-Thirty Mining Company was one of the largest producers at Silver Plume. Most of the output was from dump ores, yielding silver, lead, and zinc. The ore was treated in the Pelican mill. The Burleigh tunnel, to drain the Seven-Thirty property, was almost completed in 1908.

The Aliunde Consolidated Mining Company made an increased production of lead-silver ore from the Aliunde and Colorado Central claims. The Astor-Stewart Mining and Milling Company shipped a car of silver-lead ore to the smelter. The Bellevue-Hudson property was operated by the Columbia Gold Mining Company. The Joplin Tunnel Gold and Silver Mining Company's production was chiefly from lead and zinc concentrates. The Linn Consolidated Mining Company treated some ore in the company's concentrating plant; the chief output was in lead and zinc, with less gold and silver. The production from the Magnet group, operated through the Doric tunnel, was in gold and silver. The Main Gulch and the Whiting mining companies produced lead-zinc ores, the greater part of which was milled. The production from the Two American Sisters Mining Company was below that of 1907. The Democrat Mountain Mining Company, one of the largest producers in the district in 1907, did not operate in 1908.

Idaho district.—In this district are listed the mines about Idaho Springs, including Banner, Coral, Jackson, Lower Fall River, Payne's Bar, Spanish Bar, and Virginia subdistricts.

The production of metals from deep mines in this district was $507,405 in gold, 263,479 ounces of silver, 212,435 pounds of copper, and 779,709 pounds of lead, with a total value of $707,838. This was a total increase in value for 1908 of $310,567. There were 35 productive deep mines. The tonnage was 66,147 short tons. As compared with a production of 33,481 tons in 1907, an increase of 32,666 tons was shown. Over four-fifths of the total value came from 5 mines, the Gem Consolidated Mines, the Specie Payment, the Little Mattie group, the Sun and Moon group, and the Shafter mine.

The Gem Consolidated Mines, worked through the Newhouse tunnel, took out an increased tonnage from the Freighter's Friend and the Gem Extension mines. The greater part of the ore was milled in the company's concentration mill. The Specie Payment ore is treated at one of the concentrating mills of Idaho Springs. The mine is developed by a tunnel 2,500 feet long. The Little Mattie Mining, Milling and Power Company, on Chicago Creek, treated most of its ore in the plate-amalgamation and concentration mill on the ground.

The Sol Luna Mining Company, lessee on the Sun and Moon, sent an increased tonnage through the Newhouse tunnel to the custom concentrating mills. The Shafter Mining Company, in Spanish Bar subdistrict, has an incline shaft 893 feet deep, with a 4,700-foot crosscut and 7,000 feet of drifts. The milling ore from the mine is shipped to the 20-stamp amalgamation and concentrating mill of the Hudson Reduction Company at Idaho Springs.

The Big Five Ore Reduction and Tunnel Company advanced its tunnel 897 feet in 1908 and shipped ore to smelters. Milling and smelting ores were taken out of the Diamond Joe, Mona, Castleton, Victor, and Trio claims, all near the head of Virginia Canyon. The Silver Age and Franklin claims, near the Gem Consolidated mines, were worked by lessees. The Humboldt Mining and Tunnel Company, at the head of Chicago Creek, treated ore in its mill on the ground. The Freeland Company shipped a little ore to concentrating mills and smelters. The Stanley Mines Company, on Clear Creek, milled most of its ore. Ore containing gold, silver, copper, and lead was shipped from the Kitty Clyde mine, on the west side of Spring Gulch. The Lincoln Mining and Milling Company, on the southwest side of Clear Creek, below the mouth of Trail Creek, milled ore producing gold, silver, and copper. The Honest John Mining Company, owning the Black Eagle and Yellow Jacket claims, has a vertical shaft 585 feet on the former claim. The company was engaged in completing a 25-ton amalgamation and concentrating mill. The production of the Consolidated Quito Mining and Milling Company, south of Idaho Springs, was from both milling and smelting ores. The Lucania Tunnel and Mines Company, with mines in both Clear Creek and Gilpin counties, has driven 4,209 feet of tunnel from the portal on Fall River (Clear Creek County), in a northeasterly direction, toward Russell Gulch district, in Gilpin County. A small shipment of ore was sent to concentrating mills in 1908. The Kinda mine, lying close to the line of the Lucania tunnel, was worked during the last three months of 1908, and ore was shipped to smelters. The Almaden Mines Company, on Fall River, about 2 miles above its mouth, shipped several cars of silver-lead ore to smelters.

Montana district.—The Albro mine, near Dumont, was the largest producer in this district for 1908. Small producers were the Lost Treasure, the Dictator, the Joe Reynolds, and the Millington mines.

Trail Creek district.—The principal mine in this district was the Lamartine, which, like the Centurion and Donaldson mines, was worked by lessees. At the close of the year the Banner Consolidated Mines Company took over the Centurion holdings and will work both groups through the Rockford tunnel, which has tapped the Donaldson vein at a depth of 1,600 feet. The shaft on the Donaldson is down 600 feet. Some ore was extracted from the mines of the Freeland Extension Mining Company, the January Mining Company, the New Era Mining Company, and the Poorman Mining and Milling Company.

Upper Union (or Empire) district.—There were 3 productive properties near Empire in 1908. The Empire Tunnel Company made an increased production, chiefly of gold. The mine of the Empire Mint Company and the Golconda mine produced some gold ore.

Yankee (or Alice) district.—The Alice Development Company, owning the Alice mine, which is said to contain the largest body of low-grade ore developed in Colorado, operated the mine and mill in an experimental way during the summer of 1908. The mill is a 25-stamp and concentration plant.

CONEJOS AND COSTILLA COUNTIES.

There were no shipments from these counties in 1908. The Colorado Turquoise Mining Company, at La Jara, in Conejos County, reported development work on its property.

The Mountain View Mining and Milling Company, at Russell, in Costilla County, also reported development work.

CUSTER COUNTY.

The value of the output from Custer County in 1908 showed a decrease of $11,934. From 7 properties there were produced $7,183 in gold, 13,156 ounces of silver, a nominal output of copper, and 120,330 pounds of lead. There was a slight increase in the value of gold produced and in the quantity of lead, but the quantity of silver fell off about one-half. The production for 1909 promises to be greater than for some time past.

In 1908, there were 3,256 tons of siliceous ore treated or shipped to smelter, with an average value per ton of $3.62 in gold and silver. Of lead ore 444 tons, valued at $5.33 per ton in gold and silver, were shipped.

The Gladstone Reduction Company, at Querida, on the Bassick, and the Bull Domingo, at Silver Cliff, were the principal producers. At the beginning of 1909 the capacity of the Gladstone cyanide tailings plant was increased to 60 tons per day. Several small properties near Silver Cliff were worked. These included the Major, Augusta, Bismuth, King of the Carbonates, Ben West Hill, and Hornsilver. The Geyser Silver Mining Company, in the process of opening up the old Geyser property, made a small trial shipment. This mine has the deepest shaft in the State.

The Marion Mines and Mills Company, at Fairview, completed a 100-ton concentrating mill. The mine is opened by a short tunnel. The Custer Mining Company, owning the Dakota Bill, Campbell, and other claims, and a concentrating mill at Westcliffe, did considerable development work. At Ilse the Terrible mine was unwatered.

DOLORES COUNTY.

Dolores County in 1908 produced 11,024 short tons of ore, containing $37,238 in gold, 163,563 ounces of silver, 42,495 pounds of copper, nearly a million pounds of lead, and about half as much zinc, with a total metal value of $193,281, an increase over that of 1907 of $136,252. Though there were but 5 producing mines in 1908 as compared with 8 in 1907, there was a marked increase in the production of gold, silver, lead, and zinc. The only falling off was in copper.

There were 9,381 tons of ore treated in concentrating mills, with an average value in gold and silver in the concentrates produced of $23.91, and 1,643 tons of crude ore were shipped to the smelter, with an average value in gold and silver of $38.26.

Lone Cone district.—The principal mine in this district is the Emma mine, the ore of which runs fairly high in gold and silver. The Milwaukee Gold Mining Company, which closed down in December, 1907, did not operate in 1908. There is a 10-stamp mill on the property.

Pioneer (or Rico) district.—This old camp experienced a revival in 1908. Both company management and lessees on several properties

took out five times as much ore as in 1907. The heaviest producer was the United Rico Mines Company. Most of the ore was milled in the Pro Patria separation and concentrating mill and produced a high-grade lead and zinc concentrate. After the destruction of the mill by fire in October a considerable quantity of crude lead-silver ore, with an appreciable assay in gold, was sent to the smelter. The development of the property was actively continued. Shipments during the year were from the ore body discovered in 1907 on the General Sheridan claim. Two tunnels, one 1,700 feet long, and one 1,600 feet long, 280 feet apart vertically, open this property. Some copper ore was shipped from the Blue Bell and the Fourth of July properties. Lessees on the Swansea-Newman shipped to Durango several cars of ore containing gold and silver.

EAGLE COUNTY.

Mine production of gold, silver, and associated metals in Eagle County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	2,594.88	$53,641	2,812.09	$58,131	+ 217.21	+$4,490
Silver.....do....	70,586	46,587	86,715	45,959	+ 16,129	− 628
Copper.....pounds..	14,270	2,854	66,141	8,731	+ 51,871	+ 5,877
Lead.....do....	193,690	10,266	11,204	471	−182,486	− 9,795
Zinc.....do....	507,949	29,969	.....	.....	−507,949	−29,969
	.....	143,317	.....	113,292	.....	−30,025

The value of the mineral production of Eagle County in 1908 shows a decline of $30,025 as compared with that of 1907, the net county decrease in value being slightly greater than that of zinc. There were only 8 producing mines in 1908, as compared with 14 in 1907. There were 3,009 tons of ore sold, all of which went to smelters. The value per ton of ore was $19.29 in gold and $15.27 in silver, a total of $34.56 in gold and silver.

Battle Mountain district.—The Bleak House mine, usually a producer of lead-zinc ores carrying silver, was unproductive in 1908. Of the 13 producing mines in this district in 1907 only the First Chance, Ground Hog, Pursey Chester, Whipsaw, and Wyoming Valley produced in 1908. The Ben Butler, Rocky Point, and Star of the West mines made their first shipments in 1908. The principal mines are the First Chance and the Ground Hog. The former is opened by an incline tunnel 1,400 feet long and the latter by 2 tunnels, 1,500 feet and 1,800 feet long, respectively. There was also shipped from the Ground Hog to the steel mills at Pueblo a large tonnage of iron-manganese ore. The ore from the Rocky Point mine was chiefly valuable for copper, silver, and gold. The Iron Mask mine has been closed since December, 1907. The erection of a mill was started at the close of the year 1908.

Fulford district.—There was no work done in this district in 1908.

Holy Cross district.—In Holy Cross district development work only was reported. The South Homestake Mining Company spent several months in development work on the South Homestake placer, and expect to complete the equipment for hydraulicking in 1909.

FREMONT COUNTY.

The nominal production of Fremont County consisted in two small shipments of ore, from the Boma mine at Whitehorn and from Coaldale.

No shipments were made from the Red Gulch district in 1908. On the Copper Prince property and on that of the Fremont Copper Mines Company development work was carried on.

No shipments were made from the Currant Gulch district, at Parkdale. The Murray-Isabel mine, opened by a 310-foot shaft, did some development work.

GILPIN COUNTY.

Mine production of gold, silver, and associated metals in Gilpin County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	45,399.36	$938,488	52,042.21	$1,075,808	+6,642.85	+$137,320
Silver.....do....	209,347	138,169	187,030	99,126	− 22,317	− 39,043
Copper.....pounds..	874,060	174,812	636,371	84,001	− 237,689	− 90,811
Lead.....do....	611,060	32,386	538,143	22,602	− 72,917	− 9,784
	.....	1,283,855	.....	1,281,537	.....	− 2,318

In 1908 Gilpin County produced 120,761 short tons of ore, as compared with 87,887 tons in 1907, an increase of 32,874 tons. The number of producing deep mines was 110, or 32 more than in 1907. The placer production, always small, greatly decreased. The total value of the production decreased because of the decreased production of copper and lead and of the low prices paid for silver, copper, and lead. The production of gold in 1908 was $1,075,808, an increase of $137,320 over that of 1907. The decrease in the quantity of silver produced was not marked, but the decrease in value was considerable.

The output of both gold and silver from lead ores increased, but the product from copper ores was diminished. The gold in siliceous ores increased, but the silver from that source decreased.

The tonnage of siliceous ore mined was 117,014 tons in 1908, an increase of 31,316 tons. The copper ores decreased from 1,880 tons to 1,329 tons, but the lead ores increased from 309 tons to 2,418 tons.

The average value per ton of siliceous ore in gold and silver was $9.39, of which $8.72 was for gold.

During 1908 there were treated at the stamp amalgamation mills in Black Hawk and Idaho Springs 97,938 tons of ore, and the bullion saved on the plates was valued at $263,671 in gold, an average of $2.69 per ton, and $3,286 in silver, an average of $0.03, a total value in gold and silver of $266,957, and an average value of $2.72 per ton. From this ore treated at the amalgamation mills, and from 5,578 tons of ore sent to mills for concentration only—a total for both classes of 103,516 tons, or 85.7 per cent of all tonnage produced—were produced 17,162 tons of concentrates, valued at $308,223 in gold, an average of $17.96 per ton, and $46,492 in silver, an average of $2.71 per ton, a total in gold and silver of $354,715, and an average of $20.67 per ton.

There were recovered from the total milling ore $571,894 in gold from both bullion and concentrates, an average of $5.52 per ton, and $49,778 in silver, an average of $0.48, a total in gold and silver of $621,672, and an average of $6 per ton.

Crude ore shipped to smelters amounted to 17,245 tons, valued at $503,533 in gold, averaging $29.20 per ton, and $49,346 in silver, averaging $2.86 per ton, a total in gold and silver of $552,879, and an average of $32.06 per ton.

There are approximately 900 stamps in the various stamp mills in the county.

Progress marked the year in Gilpin County, as shown by the increased tonnage and an increase in gold production. At Black Hawk the sampling works and the stamp mills, with a few exceptions, were operated to their full capacity. Several important discoveries were reported and several old properties, under new capital, were reopened, unwatered, and in course of development, increasing the aggregate tonnage with many small lots for testing purposes. Probably 50 per cent of the operators in Gilpin County were lessees.

Of greatest importance to the future of Gilpin County was the ratification of contracts between mine owners and the Newhouse Tunnel Company. The Newhouse tunnel in 1907 had attained a distance of 17,000 feet from the portal to the Great Mammoth mine. Here work stopped until the owners and operators of the mines to be cut by the tunnel should agree upon some basis of royalty to be paid the company for extending the tunnel. After full discussion the matter was finally adjusted. A royalty was fixed at 25 cents per ton on all milling ore and $1 per ton on all smelting ore produced, as a drainage fee, and it was also agreed that miners had the privilege either of shipping their ores through the tunnel to Idaho Springs or hoisting them to the surface and sending them to the mills and sampling works at Black Hawk. In December, 1908, work was resumed on the tunnel, the objective point being the Eureka mine, a distance of 5,000 feet from where work had ceased in 1907. This tunnel will drain the Quartz Hill and Gunnell Hill properties, long idle on account of being filled with water at depths of from 1,500 to 1,700 feet, which in the majority of mines will be from 400 to 700 feet below the depth of their present shafts. The area to be drained is credited with a production of $55,000,000 since the discovery of gold in the region. The estimate of time required for the completion of the tunnel is twenty months from December, 1908.

The Gilpin County Chamber of Commerce, of Central City, has recently compiled a list of all the districts, with their mines, from the county and other records.

"Like all other mining counties, Gilpin County is divided, by somewhat indefinite lines, into mining districts having local names. These names appear to differ with individuals. The 'old timers' have one name and the more recent arrivals another for the same section. The result is confusing, unless the entire list becomes familiar."[a]

Central district.—This district embraces the vicinity of Central City. There was a small production from the Bull of the Woods and Buckley mines, the mines of the Schoolhouse Mining and Milling

[a] The Gilpin County Chamber of Commerce folder, Central City, 1908.

Company, and the Eldorado, Huddleston, Hunter Extension, and Troublesome mines.

Enterprise district.—The Four Mile Gulch Mining and Milling Company shipped lead ore to the smelter and milling ore to the concentrator. The Clear Creek Mining and Milling Company, with 48 canvas tables, 2 Frue vanners, and 2 Wilfley tables, produced concentrates containing gold, silver, and copper from mill waste. The Jennie Blanche and the Brack Hollow mines produced some smelting ore.

Eureka district.—This district, west of Central City, embraces Gunnell Hill and Eureka and Prosser gulches. There was an increased production in 1908. The German Gold Mining and Milling Company operated its Bullion mine from May through December. The Concrete mine, as well as the Eureka mine, the proposed terminus of the Newhouse tunnel, were in operation the latter part of the year. The mine was cleaned out and retimbered. Development work was confined to the 350-foot and 450-foot levels. The shaft is down 560 feet. The Gold Collar mine and the West Whiting mine were worked under lease.

Gregory district.—This district embraces Black Hawk, Gregory, Bobtail, and Bates Hills mines. It is the second district in importance of production, the first being Russell. In 1908 there were 14 mines which produced 37,268 tons of ore, from which was recovered $246,373 in gold, 30,771 ounces of silver, 198,707 pounds of copper, and 14,119 pounds of lead, with a total value of $289,504.

Producing mines in this district were the Bates-German, Dump, Chicago-Carr and Plymouth, Gregory Cyrus, Nemaha, New National, Next President, O. K., Ontario, Rome Gardner, Running Lode, Senator, and Sleepy Hollow.

The Chicago-Carr mine was worked under lease. The Fifty Gold Mines corporation, operating the Gregory, Bobtail, Fiske, Cook, Mammoth, and other properties for company account and by lessees, made an increased production. The Cook shaft is down 1,450 feet, and the Bobtail and the Fiske shafts are each down 1,400 feet. The plans for development are to sink on the Cook shaft and to extend the crosscut on the 1,400-foot level of the Cook shaft to the Gregory vein; also, to increase the mill equipment of 50 stamps. The company has made extensive experiments in applying cyanide processes to the low grade ores of the county.

During the last three months of the year the Gregory-Buell Consolidated Mines Company was unwatering its Buell shaft to a depth of 800 feet. The company mill of 45 stamps was operated continuously on custom ore. The Nemaha mine was worked for several months during the year. The Great Bonanza Mining Company worked its Next President mine and treated the ore in its 25-stamp mill, provided with bumping tables. The Aztec Mines Company deepened its shaft on the O. K. property to 675 feet and took out ore which was mainly treated at custom mills. The Gower Mines Syndicate (Limited) took out some ore.

Illinois Central district.—This district, about 1 mile south of Central City, embraces Illinois and Leavenworth gulches and the east portion of Quartz Mill. The producing mines reporting were the Alps, Delmonico, East Calhoun, East Missouri, Great Mammoth, Kirk, Paola, Quartz Mill, and Wood. The Kirk and Wood mines are known also for their uranium ores.

Lake district.—This district, 1 mile southeast of Central City, and generally known as Lake Gulch, includes the following producing properties: Justice, East Notoway, Gulch, and Caledonia mines. The production for 1908 of this district has been included with that of the Russell district, in order to compare it with the production of 1908.

Nevada district.—This district, embracing the vicinity of Nevadaville, is the third largest producing district. The producers in 1908 were the Barnes, Rome Gardner, First National Kansas, Hubert Mines Company, Little Pittsburg, Pyrenees and Nimrod, Ralls County, and San Juan and Climax mines.

Quartz Valley district.—This district, 1 mile north of Central City, made a small production from the Hayseed Tunnel, George W. Ellery, Spur Daisy, and Robert Emmet mines.

Russell district.—The Russell district lies southwest of Central City, extending to the Clear Creek County line, and is the most important district in Gilpin County. The total production in 1908 was 59,071 tons of ore, from which were produced $614,411 in gold, 128,226 fine ounces of silver, 339,629 pounds of copper, and 210,571 pounds of lead, the total value of the output being $736,045.

The mines in the district in 1908 producing precious metals alone were the Chase, Federal, Gulch, Hillhouse, Lillian, Pewabic, Troublesome, Two Forty, War Dance, Wellington, and Star of the West. Mines producing copper in addition to gold and silver were the Anchor, Argo, East Leavenworth, East Notoway, Frontenac, Hall, Hampton, Ispara, Jefferson, Old Town, Pittsburg, Saratoga and Gaston, and West Notoway. Mines producing lead in addition to gold and silver were the Addduddell, Anchor, Druid, and Jefferson.

The shaft on the Anchor property, of the Hearne Gold and Copper Company, is now 400 feet deep. The Chase mine, with a 500-foot shaft, was closed in March. The East Leavenworth shaft was sunk from the surface 267 feet during the year. The Old Town mine was worked by lessees. Ore from below the 1,500-foot level was shipped through the Newhouse tunnel, and ore from above this was hoisted to the surface and shipped to Black Hawk.

The Pewabic Consolidated Gold Mines Company has 4 shafts on its property, 2 of which are 700 feet deep. The company operates the New York 50-stamp mill at Black Hawk. The War Dance mine produced high-grade tellurium ore in 1908. Development work was done on the claims of the King Bee Gold Mining Company. A lateral was driven from the Wellington mine to the Newhouse tunnel, a distance of 400 feet, and 794 feet of drifting was done on the Wellington. There was considerable work done also on the Clifton Bell, Iron Duke, Compensation, and Waterloo claims. On the Missouri mine, which is opened by a 375-foot shaft, development work was also done in 1908.

Other districts.—The outlying districts in Gilpin County are the Vermilion district, 4 miles northwest of Central City; the Pine district, 7 miles northwest of Central City; the Independent and Union districts, about 9 miles north of Central City, embracing Perigo and Rollinsville, Lump Gulch, and Moon Gulch sections; and the Phoenix district, along the north edge of the county, near the Boulder County line.

The Ann Rutledge Gold Mining Company and the Golden Sheaf mine (both in Vermilion district), the Evergreen Gold and Copper

Mines Company, and the Gilpin Independence Mining Company (both in Pine district), were small producers. At Rollinsville, the Perigo Mines Group and mill were worked continuously under lease, and the Penobscot Mining and Milling Company, under active development, ran its mill at intervals.

The A. K. R. Gold Mining and Milling Company, at Rollinsville, in the Union district, produced steadily in the latter part of 1908. The ore was treated in the 10-stamp mill. The Champion Mining and Milling Company, in the Phoenix district, treated part of its ore in the company's mill, and sent part of it to Black Hawk.

GRAND COUNTY.

Two small lots of ore were shipped in 1908 from the Grand Lake and La Plata districts. Several properties report development and prospect work.

The extension of the Denver, Northwestern and Pacific Railway ("Moffat Road") through Grand County has given access to the mines of the county and has stimulated some activity in prospecting.

GUNNISON COUNTY.[a]

Mine production of gold, silver, and associated metals in Gunnison County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	2,978.40	$61,569	4,839.05	$100,032	+ 1,860.65	+$38,463
Silver.....do....	27,277	18,003	28,664	15,192	+ 1,387	− 2,811
Copper.....pounds..	13,690	2,738	5,481	724	− 8,209	− 2,014
Lead.....do....	120,226	6,372	327,612	13,760	+ 207,386	+ 7,388
Zinc.....do....	68,644	4,050	147,000	6,909	+ 78,356	+ 2,859
	.....	92,732	.....	136,617	.....	+ 43,885

[a] For a brief account see Hill, J. M., Notes on the economic geology of southeastern Gunnison County, Colo.: Bull. U. S. Geol. Survey No. 380, 1909, pp. 21–40.

The value of the mineral production of Gunnison County in 1908 showed an increase over that of 1907 but does not equal that of 1906. In 1908 the only decline was in the quantity of copper produced. There was a marked increase in the quantity of gold and lead produced.

Box Canyon district.—The Brant Independent Mining Company, operating the Camp Bird mine, near Bowerman, made a decided increase in output, as compared with that of 1907. The 10-stamp amalgamating and concentration mill was in operation the greater part of the summer. Most of the gold in the ore was caught on the plates. Some crude ore and concentrates shipped to the smelter brought high returns. The Abe Lincoln Mining and Milling Company has a 10-stamp concentration mill on its property, which is developed by 4 tunnels, aggregating 1,200 feet. The mill has not been operated since its erection.

Cochetopa district.—Lessees on the Maple Leaf mine at Sillsville treated ore in a small amalgamating and concentration mill.

Elk Mountain (or Ruby) district.—There were 3 productive mines in this district in 1908. The lessee on the Lucky Strike mine shipped a considerable amount of bullion from a small mill. A small production was made by the Blaine Mining and Reduction Company at Gothic. A 10-stamp mill was built but made only a short run. The mine is opened by tunnels, the lowest being 700 feet in length. The Lehrritter Mining Company shipped to smelters. Much ore could not be shipped because of the deep snow during the last months of 1908.

Gold Brick district.—This remains the leading district in Gunnison County, with Tomichi district second. The Colorado Smelting and Mining Company, operating the Gold Links mine, produced bullion and concentrates. The Grand Prize Mining and Reduction Company shipped some gold-silver ore. The Raymond Consolidated Mines Company ran its 20-stamp mill with plate amalgamation and Wilfley concentration nine months of the year. The adit tunnel is 2,300 feet long. The Belzora Bassick mine, at Ohio, is opened by 2 tunnels, 1,200 feet and 1,300 feet long. Development work was continued. The adit of the Carter Mining Company was driven 1,000 feet and is now 5,036 feet long.

Quartz Creek district.—The Colorado Quartz Creek Mill Company made a short run with its 10-stamp concentrating mill built during the year. Development work was done on the Pandora mine.

Rock Creek district.—The Black Queen mine, at Crystal, was worked for a month, and a tonnage of ore was milled at the company's 40-ton concentrating plant equipped with rolls, tube mill, and Wilfley tables, and run by water power. The mine is opened by a 525-foot incline.

Tin Cup district.—A small shipment of bullion was made by the West Gold Hill Mining Company. The Brunswick Mining and Milling Company was idle. The United Colorado Mines Company, whose property is situated near Dorchester, on the Taylor River, drove 248 feet on an adit that now measures 5,444 feet. The equipment consists of a 50-ton concentrating mill.

Tomichi district.—The output from this district showed an increase over that of 1907. The leading producer of the district was the Morning Star mine, from which was shipped lead-zinc ore, carrying silver. Some lead-silver ore was shipped from the Doctor and from the Morning Glim mines. Development work was done on the mines of the Erie Mines Company.

HINSDALE COUNTY.

Mine production of gold, silver, and associated metals in Hinsdale County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	363.78	$7,520	118.71	$2,454	− 245.07	−$5,066
Silver.....do....	50,109	33,072	29,498	15,634	− 20,611	−17,438
Copper.....pounds..	99,410	19,882	188,698	24,908	+ 89,288	+ 5,026
Lead.....do....	1,204,628	63,845	280,465	11,780	−924,163	−52,065
Zinc.....do....	23,034	1,359	.....	.....	− 23,034	− 1,359
	.....	125,678	.....	54,776	.....	−70,902

Hinsdale County, in 1908, produced 980 short tons of ore, valued at $54,776. As compared with the output of 1907, this was a decrease of 9,760 tons in quantity and of $70,902 in value. There were 10 productive mines in 1908 and 9 in 1907. There was a decrease in the quantity of every metal produced except copper. All the ore was shipped to smelters, and averaged in value $55.89 per ton, of which $2.50 was for gold, $15.95 for silver, $25.42 for copper, and $12.02 for lead.

Galena district.—This is the chief district in Hinsdale County. The yield from 7 mines in this district was by far the bulk of the county production. The foremost producer in 1908 was the Frank Hough mine; the ore carries mainly copper and silver. Ore containing gold, silver, and lead was shipped from the Highland Chief mine. Lead ore was shipped by the owners of the Independence mine, by the Pittsburg Metals Mining and Milling Company, and by the St. Paul-Sulphuret Consolidated Mining Company.

The Hanna Mining and Milling Company continued development work. There is a 100-ton concentrating plant on this property. The Hidden Treasure Mining Company was idle in 1908.

Lake district.—In this district, in 1908, there was a metal output valued at only $7,530, as compared with that of $44,446 in 1907. There was a very small tonnage shipped from the Old Sol, the Fanny Fern, and the Pelican mines. The Yellow Medicine mine, from which there was a large tonnage mined in 1907, was idle in 1908.

HUERFANO AND JEFFERSON COUNTIES.

There was no production from either of these counties in 1908. The Copper Bull Mining Company, at Malachite, Huerfano County, is opening a deposit of low-grade copper.

In Jefferson County, between Golden, on Clear Creek, and Evergreen, on Bear Creek, are several idle copper deposits, on some of which considerable development work has been done in the past.[a]

LAKE COUNTY.

Mine production of gold, silver, and associated metals in Lake County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	51,504.38	$1,064,690	59,426.22	$1,228,449	+ 7,921.84	+ $163,759
Silver.....do....	4,154,913	2,742,243	2,893,496	1,533,553	− 1,261,417	−1,208,690
Copper.....pounds..	2,679,510	535,902	4,674,502	617,034	+ 1,994,992	+ 81,132
Lead.....	32,519,796	1,723,549	19,646,007	825,132	−12,873,789	− 898,417
Zinc.....pounds..	37,412,374	2,207,330	23,188,080	1,089,840	−14,224,294	−1,117,490
	.....	8,273,714	.....	5,294,008	.....	−2,979,706

The low prices prevailing in 1908 for silver and the base metals caused a cessation of mining in the silver-lead-zinc properties of Leadville. Several of the large properties which had closed in the fall of 1907 remained closed until the end of the year 1908. The

[a] Bull. U. S. Geol. Survey No. 340, pt. I, 1908, p. 167.

"Gold Belt" properties, carrying gold, silver, and copper, mined a larger tonnage, with a consequently larger yield of gold and copper from the camp.

The output of zinc from this county was 23,188,080 pounds, as compared with 37,412,374 pounds in 1907. The A. Y. and Minnie mine, a large producer of zinc in 1907, was closed during 1908 until October. The Iron Silver Company, the largest producer of zinc in the county and State, shipped zinc ore from its Tucson mine, but its Moyer mine was closed.

Lake County, in 1908, ranked second to Teller County in value of production and third in tonnage. The tonnage was 18 per cent and the value was nearly 17 per cent of the respective state totals. Lake County was again first in the production of silver, copper, lead, and zinc, and in the production of gold it followed after Teller, San Miguel, and Ouray counties.

Of the State's total output, Lake County produced 32 per cent of the silver, 38 per cent of the lead, 47 per cent of the copper, and 77 per cent of the zinc.

In 1908, 61 properties yielded a tonnage of 408,711 short tons, as compared with 70 mines and a tonnage of 631,273 short tons in 1907. In quantity the decrease in tonnage was 222,562 tons, and in total average value, at average metal prices in 1908, the falling off was from $13.10 per ton to $12.95 per ton.

Classification of Leadville ores.

		Quantity.	Percentage.
		Short tons.	
Siliceous	Gold-silver	25,741	6
	Total siliceous	25,741	6
Sulphide	Zinc-iron-lead (zinc blende—pyrite, with a little galena)	95,306	23
	Iron (pyrite, with a little copper, gold, silver, and lead)	151,284	37
	Total sulphide	246,590	60
Oxide	Lead	24,616	6
	Iron-manganese (silver)	111,764	28
	Total oxide	136,380	34
	Grand total	408,711	100

As shown by this table, the greatest tonnage from Leadville in 1908 was of sulphide ore. The chief sulphide ore was iron pyrite, carrying a little copper, gold, silver, and some lead. The bulk of this went direct to the smelter. The tonnage of this class was 151,284 short tons, or 37 per cent of the total tonnage. There were also 95,306 tons, or 23 per cent, of zinc-iron-lead-sulphide (zinc blende—pyrite with a little galena). Sulphide ore made 60 per cent of the tonnage.

The higher grade of zinc sulphide ore was shipped direct to the zinc smelters without concentration. The bulk of the zinc sulphide, however, including quite a tonnage of dump ore, was separated magnetically or concentrated at Leadville, Canon City, and Denver. The Western Chemical Company, in Denver, was the only plant to run its wet mill for the further concentration of the middlings produced at the separation and concentration mills.

Next to the pyrite ore the second largest tonnage was of iron oxide, carrying about 10 per cent of manganese and a low per cent of lead, which was usually paid for as iron. This tonnage amounted to 111,764 short tons, or 28 per cent of the total tonnage. Lead oxide ores proper amounted to 24,616 tons, or only 6 per cent of the total tonnage.

Siliceous ore carrying gold and silver amounted to 25,741 tons, or 6 per cent of the total tonnage.

In the subdivision of the ores of the State on a preceding page the siliceous and dry ores include the iron-manganese oxide and part of the iron-sulphide ore and aggregate 232,657 tons, or 57 per cent of the tonnage.

Some ore containing native gold was mined in several of the Breece Hill mines.

Of both classes of sulphide ore that part which was milled, amounting to 85,200 tons, or 21 per cent of all the tonnage, made 43,557 tons of lead and zinc concentrates, which contained $27,274 in gold, 161,589 fine ounces of silver, 146,083 pounds of copper, 4,763,299 pounds of lead, and 22,733,936 pounds of zinc.[a] These figures show an average recovery per ton for the crude ore of 32 cents in gold, 1.90 fine ounces of silver, 2.8 per cent lead, and 13.34 per cent zinc.[a] The average assay of the concentrate showed 62 cents in gold, 3.74 fine ounces of silver, 5.5 per cent in lead, and 26.10 per cent in zinc.[a]

The tonnage of ore sent direct to the smelter, the bulk of which was the oxide and siliceous ores, with some lead-zinc ore and some iron pyrite, carrying copper, lead, gold, and silver, was 323,511 tons, or 79 per cent of all the tonnage. This tonnage contained $1,201,175 in gold, 2,731,908 fine ounces of silver, 4,528,419 pounds of copper, 14,882,708 pounds of lead, and 6,895,093 pounds of spelter. The average theoretical assay of the smelting ore was, therefore, $3.71 in gold and 8.44 fine ounces of silver. An average theoretical assay of the lead, copper, and zinc, based on the total tonnage smelted, has no value, as much ore did not carry lead, a greater part of the ore did not carry copper, and but little was reported as containing zinc. The 14,882,708 pounds of lead were from 214,584 tons, which gives an average per ton of 3.47 per cent of lead in all ore smelted.

The Iron Silver Mining Company, usually the chief producer in Leadville, was surpassed in 1908 by the Ibex Mining Company, operating the Little Johnny mine, and by the Yak Company. The Moyer mine, of the Iron Silver Company, was closed during the year and the output was all from the Tucson mine and the Moyer dump. The Ibex Company's yield in 1908 was above that of 1907. This mine is one of the largest in the State in point of yield. A good recovery was made by the Leadville District Mining and Milling Company on the dump ore of the Little Johnny.

The Yak Mining, Milling and Tunnel Company continued vigorous work throughout 1908 and mined the largest tonnage in Leadville. The value of the company's yield took second place during 1908. Silver represented the highest value of the yield from the mines of this company, with zinc second, and copper, gold, and lead in the order named.

[a] This amount of spelter recovered is an estimate based on 80 per cent saving from crude ore smelted and 64 per cent of the assay saved when the ore is milled and then smelted. It is estimated that of the 22,733,936 pounds of zinc contained in the concentrate 16,292,987 were recovered as spelter.

The Yak tunnel's main artery reached a point 3 miles from the portal by January 1, 1909. Other branches into the adjacent territory of Iron and Breece hills make several more miles of workings for drainage and transportation.

The tonnage from the mines of the Western Mining Company was less than that of 1907. All the ore was treated in the Adams mill, a 200-ton concentrating plant. The ore, in the form of lead and zinc concentrates, was sold to lead and zinc smelters. The shaft on the Wolftone mine is down 1,170 feet; on the Adams, 810 feet; and on the Castleview, 800 feet.

The New Monarch Mining Company shipped an increased tonnage of gold-silver ore with appreciable values in lead and copper from the New Monarch and Cleveland mines.

The operators of the Fannie Rawlings mine, on Breece Hill, shipped iron sulphide ore, with chief values in gold, silver, and copper.

Lessees on the Breece-Iron mine shipped a large tonnage of oxide iron ore (with a trace of manganese), with values in gold and silver.

The A. Y. and Minnie mines remained closed from November, 1907, to October, 1908. The production during the last months of 1908 materially increased the output of lead and zinc from the camp.

Other productive companies and mines of note were: On Breece Hill, the Highland Chief, the Garbutt, the Humboldt, the Big Four lease, and the Luema Mining Company (Valley mine); on Iron Hill, the Terrible Mining Company (Adelaide mine), the Golden Eagle Mining Company (Vinnie mine), and the Empire Zinc Company (Rubie mine); on Fryer Hill, the Dunkin, Matchless, Boreel Mining Company, and Little Sliver; on Rock Hill, the La Plata Mining Company, the Nisi Prius, and the New Emmett Mines Company; on Carbonate Hill, the Morning and Evening Star; in the Down Town district, the Midas Mining and Leasing Company (Coronado mine); the Favorite, in Iowa Gulch; and the Halcyon Mining Company (Silent Friend mine), in South Evans Gulch.

LA PLATA COUNTY.

From 2,408 short tons of ore there were produced in 1908 in La Plata County 4,900.39 fine ounces of gold, valued at $101,300, and 71,487 fine ounces of silver, valued at $37,888, a total value of $139,188. As compared with 1907, the decrease in the value of the output was $416,834. Shipments were made by 9 companies, as compared with 7 in 1907, but there was a decreased tonnage from the important mines of the county in 1908.

The May Day, Valley View (including the Idaho), and Tomahawk mines were worked steadily and from all of them high-grade ore was shipped. Ore was also sent out from the Small Hopes, Volcanic, Gold Dollar, Graves, Little La Plata, and Bonnie Girl mines. On the Bonnie Girl property is a 50-stamp amalgamation mill.

The Boren Gulch Mining Company has been developing its property steadily since 1902. Ore has been placed on the dump and it is reported there is enough blocked out to warrant the building of a mill. Development work was reported on the White Diamond mine. The Lucky Four, a producer in 1907, was idle in 1908.

Nearly all the ore was shipped to smelters. The average value per ton was $42.07 in gold and $15.73 in silver, a total of $57.80 per ton.

MINERAL COUNTY.

Mine production of gold, silver, and associated metals in Mineral County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold..... fine ounces	5,705.34	$117,960	5,779.07	$119,493	+ 54.08	+ $1,117
Silver..... do	970,456	579,501	725,092	384,593	− 144,858	− 189,032
Lead..... pounds	10,456,962	968,869	1,731,987	72,765	− 8,924,975	− 432,076
Zinc..... do	1,859,150	108,450	1,100,107	51,705	− 759,029	− 56,745
		1,305,730		628,990		−737,636

The value of the metallic production from Mineral County in 1908 was 46 per cent of that of 1907. The greatest decrease was in the output of lead, which fell from 10,656,962 pounds to 1,731,987 pounds, a decline of 84 per cent. The silver yield showed a decrease of only 17 per cent, though siliceous ore, the main source of silver in 1907, fell off 25,412 tons, or 85 per cent, and lead and lead-zinc ores fell off 38,240 tons, or 51 per cent.

Of the total tonnage of 61,131 tons mined, over one-half was milled, and the rest was sent to smelter as crude ore. The total average value of the ore mined is represented by the following theoretical assay for the county, based on the returns: Gold, 0.094 ounces; silver, 11.87 ounces; lead, 1.42 per cent; zinc, 0.89 per cent—an average value for 1908 of $10.27 per ton. In 1907, the total average value of the ore was $13.01.

Only 7 mines were productive in 1908, as compared with 10 in 1907. The Creede United Gold Mines Company was idle during the year. The Del Monte Leasing Company was the largest producer, shipping crude lead-silver ore.

The Amethyst Mining Company treated its sulphide ores in its 100-ton concentration plant. The mine has an incline shaft 1,450 feet deep. Other producers of carbonate ore were the Bachelor Mining Company, Commodore Mining Company, Alpha and Nelson mines, and the Monte Carlo Gold and Silver Company from the Champion mine. The Ridge and Mexico Mining Company was idle in 1908.

MONTEZUMA COUNTY.

There was one small shipment from the Mancos section in Montezuma County in 1908. The production has been combined with that of Saguache and Rio Grande counties.

OURAY COUNTY.

Mine production of gold, silver, and associated metals in Ouray County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold..... fine ounces	110,428.00	$2,413,649	96,139.28	$2,029,138	− 14,288.72	− $384,511
Silver..... do	562,519	292,063	445,050	230,987	− 117,469	− 61,076
Copper..... pounds	410,720	92,144	1,010,574	134,584	+ 599,854	+ 42,440
Lead..... do	3,490,856	135,529	1,075,441	70,367	− 2,415,415	− 65,162
Zinc..... do	50,407	1,794	.....	.....	− 50,407	− 1,794
		2,918,989		2,464,076		− 463,353

Ouray County, one of the "San Juan" counties, was one of five in the State which made a production of over $2,000,000 in 1908, and ranked third in production of gold and fourth in total metallic production. The yield of gold alone in Ouray County was $2,028,698, and the total metallic value was $2,453,636, a decrease of $463,353, compared with total value of 1907. The major part of the decrease was in gold production, and the rest mainly in the lead yield.

The tonnage of ore sold or treated in 1908 was 96,493 short tons, as compared with 96,662 tons in 1907. There were 21 productive mines in 1908 and 25 in 1907. The average total value per ton in 1908 was $25.43, as compared with $30.18 in 1907. The average value per ton in gold was $21.02.

The tonnage of siliceous ore decreased from 91,763 short tons in 1907 to 90,741 in 1908; of lead ores, from 1,677 tons to 248 tons; of copper-lead, from 2,549 tons to 768 tons; whereas copper ores increased from 578 tons to 4,715 tons.

During 1908 there were treated at gold and silver mills 89,631 tons, and the bullion contained $1,707,332 in gold, an average recovery per ton of $19.05, and $24,391 in silver, an average recovery of 27 cents per ton, a total value in gold and silver of $1,731,723, and an average value of $19.32 per ton. From the same ore treated at amalgamating mills were produced also 8,125 tons of concentrates, valued at $262,923 in gold, an average value of $32.36 per ton, and $105,166 in silver, an average value of $12.94 per ton, a total in gold and silver of $368,089, an average of $45.30 per ton. The value of both bullion and concentrates recovered from the milling ore was $1,970,255 in gold, an average of $21.98, and $129,557 in silver, an average of $1.45 per ton, a total in gold and silver of $2,099,812, and an average of $23.43 per ton for all ore milled.

Crude ore shipped to smelter amounted to 6,862 tons, valued at $58,443 in gold, averaging $8.52 per ton, and $90,430 in silver, averaging $13.18 per ton, a total in gold and silver of $148,873, and an average of $21.70 per ton.

Sneffels district.—The production from this district was not up to the large figures of 1907. The output of the Camp Bird mine for the calendar year 1908 did not equal the yield for 1907, though it was still the largest producing mine in the State. This mine is developed by 2 tunnels, 2,071 feet and 979 feet in length, and a shaft 937 feet deep. A 60-stamp plate-amalgamation mill, with concentration, and a cyanide plant for tailings comprise the milling plant. The Atlas Mining and Milling Company's output for 1908 was below that of 1907. An adit tunnel of 2,000 feet, with drifts east and west, opens this property. During the year 30 additional stamps were added to the old mill of 10 stamps. The Revenue Tunnel Mines Company, under lease, surpassed its yield of 1907. The Torpedo-Eclipse Mining Company made a small shipment in the course of development work. The company is erecting a 10-stamp amalgamating and concentration mill. The mine is developed by 5 adits, aggregating 2,470 feet in length.

Paquin district.—The Newsboy-Slide was the only productive mine in this district, and was operated during the entire year. The ore carries values in gold, silver, and lead.

Red Mountain district.—This district showed an increase for the year 1908, mainly due to the operations of the San Antonio Mining

Company, which shipped a large tonnage of copper ore, carrying gold and silver. The mine has a shaft 200 feet deep. The Koehler adit was extended 850 feet. The Red Mountain Railway, Mining and Smelting Company was also a producer of copper ore, from the Yankee Girl and the Genessee mines. The Genessee mine is opened by a tunnel 5,000 feet long, and the Yankee Girl mine by a shaft 950 deep. The Continental American Gold Mining and Milling Company shipped copper ore from the Iron City mine. The Mono-Baltic Mining and Smelting Company operated its mines eight months of the year, and shipped some copper ore.

The greater part of the copper production of the county comes from this district.

Uncompahgre district.—There was a slight increase in the quantity of lead produced in this district, but the value of the total metallic output was much below that of 1907. The largest decrease was in the production of gold.

The American Nettie mine greatly increased its production. Some ore was shipped from the dump of the Bachelor mine, and lead ore was shipped by lessees from the Pueblo mine. Other mines from which small shipments were made were the Portland, Grizzly Bear, O. & N., Cascade, Jonathan, John L., Rock of Ages, and Uncle Sam.

PARK COUNTY.

Mine production of gold, silver, and associated metals in Park County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	24,826.82	$513,216	20,840.33	$430,808	−3,986.49	−$82,408
Silver.....do....	111,215	73,402	12,047	6,385	− 99,168	− 67,017
Copper.....pounds..	.....	.....	37,106	4,898	+ 37,106	+ 4,898
Lead.....do....	1,062,732	56,325	495,985	20,831	− 566,747	− 35,494
Zinc.....do....	333,407	19,671	728,000	34,216	+ 394,593	+ 14,545
	.....	662,614	.....	497,138	.....	−165,476

This county in 1908 produced 20,840.33 fine ounces of gold, valued at $430,808; 12,047 fine ounces of silver, valued at $6,385; 37,106 pounds of copper, valued at $4,898; 495,985 pounds of lead, valued at $20,831, and 728,000 pounds of zinc, valued at $34,216, a total value of $497,138. This was a decrease of $165,476, as compared with the value of the output for 1907. The tonnage treated was 11,372 short tons, a reduction of 1,289 tons for 1908. The greater part of the ore went direct to smelters. There were 13 producing quartz mines and 7 placers in 1908, against 16 quartz mines and 8 placers in 1907. The placer production for 1908 was $12,066 in gold, an increase of $5,113.

Buckskin district.—The value of the metallic production from this district in 1908 was five times that of 1907. There were 4 producing mines in 1908 and 3 in 1907. The production of gold and silver was greatly increased, and the district began to produce copper and lead.

The Etna Gold Mining Company shipped some lead-silver ore. The Ruth Manchester Company mined a large tonnage from the Iron-

clad mine. The larger part of this was sent to smelter, and the rest was milled on the ground in the company's 20-stamp concentration mill. The mine is opened by a 300-foot shaft and a tunnel.

Substantial shipments were made from the Kentucky Bell group. The Paris Mining Company ran its amalgamating mill for some time, all the product being in bullion.

Consolidated Montgomery district.—There was an increased production in this district in 1908. Shipments were made by the Ling-Star Mining Company, as well as by the owners of the Morning Star mine, and the Pinnacle and Russia mines. The tunnel in the last-named mines was advanced 500 feet, making to date of mine report 5,500 feet of workings.

Hall's Valley district.—A small shipment was sent out from the Rainbow mine.

Horseshoe district.—A greatly increased tonnage was shipped in 1908 from the zinc carbonate deposits of the Hilltop mine. This mine was reopened in 1907, after many years of idleness. The Platte River Placer Company operate the most important hydraulic mine in the county. Lack of water prevented work in 1908 except for six weeks.

Mosquito district.—The output of this district, though below that of 1907, was over four-fifths of the total metallic production of the county in 1908. The yield was from 4 deep mines and 1 placer.

The London mine maintained its place, with the heaviest production of gold and lead in the county. This mine lies at the head of Mosquito Creek, on the ridge between Leadville and Alma, and near the county lines of Lake and Park. The Butte Mining Company made several shipments of gold ore. Other shippers were the operators of the Wheeler mine and the Winnie mine.

Tarryall district.—The Apex Copper Company, of Hayman, reported development work. A small amount of placer gold was saved by hydraulicking in this district.

PITKIN COUNTY.

Mine production of gold, silver, and associated metals in Pitkin County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	28.01	$579	26.03	$538	− 1.98	− $41
Silver.....do....	1,719,446	1,134,834	1,041,700	552,101	− 677,746	− 582,733
Copper.....pounds..	10,735	2,147	.....	.....	− 10,735	− 2,147
Lead.....do....	12,235,230	648,467	7,568,060	317,859	−4,667,170	− 330,608
Zinc.....do....	5,799,746	342,185	722,362	33,951	−5,077,384	− 308,234
	.....	2,128,212	.....	904,449	.....	−1,223,763

The low prices of silver, lead, and zinc were very seriously felt at Aspen and in Pitkin County in 1908. The production of silver for 1908 was 1,041,700 fine ounces, valued at $552,101, a decrease of 677,746 fine ounces in quantity and of $582,733 in value. The output of lead was 7,568,060 pounds, valued at $317,859, a decrease of 4,667,170 pounds in quantity and of $330,608 in value. The quan-

tity of zinc also fell off 5,077,384 pounds. No copper production was reported, although the smelters show a small extraction of copper from the ores of the county. The production of gold in the county was insignificant. The tonnage sold or treated in 1908 was 133,408 short tons, a decrease of 50,428 tons.

Pitkin County in 1908 took third place in the production of silver, with San Juan County a close fourth, though for many years Aspen has been a close rival of Leadville in silver production. In the production of lead Leadville was first, with twice the output of San Juan. Pitkin was third.

The quantity of silver reported from dry ore, most of which carried less than 4.5 per cent of lead and had a siliceous or limestone gangue, was 530,928 fine ounces. The source of silver ore of next importance was lead-zinc ores, from which were extracted 438,064 fine ounces. The rest came from lead ores proper. The average assay in silver and lead of all the ore treated or sold was, theoretically, silver, 7.81 ounces; lead, 2.83 per cent.

Roaring Fork (or Aspen) district.—The larger mines of Aspen were not actively worked from the beginning of 1908 until April, when the Smuggler mill was started. Neither the Smuggler nor the Durant (which is owned by the same interests) made an output approaching that of 1907. The production from the Aspen mine was about the same as in 1907.

The Argentum-Juniata Mining Company shipped considerable siliceous silver ore.

Production was reported from the Aspen Fraction and American Fraction mines. The operators of the Spar Consolidated, Bushwhacker, Morley Zona, and Millinee mines shipped silver-bearing lead ores. The Millionaire mine, with a tunnel 6,500 feet, the Della S., with a tunnel 6,000 feet, the Franklin, opened by a tunnel 4,500 feet long, all produced lead-silver ores. The Mineral Farm Consolidated mine was worked under lease, as was the Leadville mine. The Mineral Farm has an incline shaft. Some ore was shipped from the Good Thunder and Celeste claims at Tourtelotte Park. The Percy-La Salle mines were shut down during 1908.

Lincoln district.—During the last two months of the year the Ruby Mines and Development Company's property, located in the southeast corner of the county, was worked, and ore was sent to smelter. There is a 50-ton concentration mill on this property. The workings consist of a 1,000-foot tunnel and drifts.

Columbia (or Ashcroft) district.—The Tam O'Shanter-Montezuma Mining Company developed its mine. An aerial tramway from mine to mill, about 1 mile long, is being constructed. A 50-ton concentrating mill was nearly completed in 1908.

RIO GRANDE AND SAGUACHE COUNTIES.

Four mines in Saguache and 1 in Rio Grande counties produced ore valued at less than $3,000. A small shipment of gold ore was made from Summitville, Rio Grande County.

The production in Saguache County in 1908 was about one-third of that of 1907. The decrease was nearly all in silver, the production of the other metals remaining as in 1907. A car of ore was shipped from the Independence mine, at Crestone, in the Baca land grant

In the Embargo district, in southern Saguache County, just across the line from Rio Grande County, small shipments were made from the Golden Income mine and the Last Relief mine.

In the Bonanza district a few cars of lead-silver ore were shipped from the Antoro mine.

ROUTT COUNTY.

There was very little difference in the values of the metal production in Routt County in 1907 and 1908, the increase for 1908 being only $573. The total value of the output was $5,865, of which $5,207 was in gold and $658 was in silver.

Hahn's Peak district.—A little high-grade ore was shipped from the Royal Flush group by the Hahn's Peak Gold Mining and Milling Company. The property is opened by a shaft 600 feet deep and tunnels aggregating 2,972 feet.

Placer operations in 1908 were mainly confined to hydraulic work on the Blackburn placer and dredging on the Centennial placers by the Iowa-Hahn's Peak Gold Mining Company. There were a number of small producers.

Small placer operations were carried on in the Four Mile and Lay districts. In the latter the Housel-Melvin Mining Company began hydraulic work.

SAN JUAN COUNTY.

Mine production of gold, silver, and associated metals in San Juan County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	46,814.03	$967,732	48,269.74	$997,824	+ 1,455.71	+$30,092
Silver.....do....	1,175,176	775,616	1,004,287	532,272	− 170,889	−243,344
Copper.....pounds..	2,450,280	490,056	2,282,738	301,321	− 167,542	−188,735
Lead.....do....	12,483,507	661,626	8,402,569	352,908	−4,080,938	−308,718
Zinc.....do....	237,677	14,023	10,131	476	− 227,546	− 13,547
	.....	2,909,053	.....	2,184,801	.....	−724,252

The value of the metallic production in San Juan County in 1908 showed a decrease of $724,252 as compared with that of 1907, but an increase over that of 1906. With the exception of gold, there was a decrease in yield of all the metals. The output of lead showed the greatest decline, from 12,483,507 pounds to 8,402,569 pounds, a difference of 4,080,938 pounds.

San Juan County continues to be second to Lake County in the production of copper and lead, the yield in each case being less than one-half of the output of Lake County.

The tonnage of siliceous ore mined was 180,487 short tons, as compared with 187,242 in 1907, a decrease of 6,755 tons. The copper ores decreased from 10,063 short tons to 2,149 tons, the lead ores from 35,201 tons to 19,513 tons, and the copper-lead ores decreased from 3,133 tons to 494 tons.

The average value per ton of siliceous ore in gold and silver was $6.89, of which $5.19 was gold; of copper ores, $24.24, of which

$3.36 was gold; of lead ores, $11.75, of which $2.70 was gold; and of copper-lead ores, $10.70, of which $1.91 was gold.

During 1908 there were treated at gold and silver mills 120,862 tons, and the bullion amounted to $387,459 in gold, an average of $3.21 per ton, and $2,351 in silver, an average of 2 cents per ton, a total value in gold and silver of $389,810, and an average value of $3.23 per ton. From the ore treated at gold and silver mills, and from 77,370 tons sent to mills for concentration only, a total of 198,232 tons (97.8 per cent of all the tonnage mined) were produced 37,346 tons of concentrates, valued at $584,759 in gold, an average of $15.66 per ton, and $330,532 in silver, an average of $8.85 per ton, a total in gold and silver of $915,291 and an average of $24.51 per ton.

There were produced from the ore to both classes of mills, from both bullion and concentrates, $972,218 in gold, an average of $4.90 per ton, and $332,883 in silver, an average of $1.68 per ton, a total in gold and silver of $1,305,101, and an average of $6.58 per ton for all ore milled.

Crude ore shipped to smelters amounted to 4,411 tons, containing $25,606 in gold, and averaging $5.81 per ton; $199,389 in silver, averaging $45.20 per ton—a total in gold and silver of $224,995, and an average of $51.01 per ton.

The average value in 1908 in gold, silver, copper, and lead of the entire tonnage of 202,643 tons was $10.78, of which $4.92 was for gold, $2.63 was for silver, $1.49 was for copper, and $1.74 was for lead.

Mining operations on the part of the regular shipping companies of San Juan County were not as active in 1908 as in 1907. The burning of the Gold King surface buildings in June, 1908, and the wrecking of the Iowa mill by a snowslide in March lessened the production considerably. The Silver Lake mines were worked with a reduced force during the latter part of the year. The harsh winter of 1908–1909, with the closing of railroad transportation for some months, prevented the shipment of ore and concentrates during that time. The Ross smelter was closed during the entire year.

That there was considerable progress in the county, notwithstanding, is shown by the increase in number of producing mines to 42 in 1908 from 27 in 1907. The production from new shippers was in small lots taken out in the course of development, and the aggregate did not greatly increase the output for the county.

Animas district.—There was little development done on the Aspen mine, and only a small tonnage was milled and smelted. The ore was milled in the plant of the Silver Lake mines. The Garfield Smelting Company, controlling the Silver Lake mines, treated a slightly increased tonnage in the 300-ton concentrating plant, which was completed in 1907.

The Bullion King Mining Company, with a tunnel 4,000 feet long, of which 1,508 feet were driven in 1908, shipped a small lot of ore for test purposes. The Congress Gold and Copper Company shipped several cars during the year. The Ross Mining and Milling Company made two large mill runs. Work was pursued steadily on a crosscut tunnel to cut the Champion vein, 550 feet below the present workings. The Hercules Consolidated Mining Company, with a 160-ton concentrating plant, made a greatly increased output. A smaller tonnage o

ore was treated by the Iowa Gold Mining and Milling Company from the Iowa and Tiger claims. The plant is a 150-ton concentrating mill, with crushers, coarse and fine rolls, jigs, Chile mill for regrinding, Wilfley tables, and a canvas slimes plant. The Iowa mine is developed by a tunnel 1,045 feet long to the shaft, which is 250 feet deep; the Tiger mine by a tunnel 1,340 feet long and a shaft 375 feet deep.

The Hamlet Mining and Milling Company, with a 50-ton concentrating mill, was operated part of the year. Lead-silver ore was shipped by the Little Nations Mining Company and by the Gold Tunnel and Railway Company. The latter company's 100-ton mill was idle the entire year.

The Contention Mining Company's property, under lease, and the mine and mill of the Old Hundred Mining Company, were operated for a part of the year. The latter mine is opened by 3 adit tunnels. The mill has 40 stamps, amalgamating plates, and concentrators. The Pride of the West mine was worked under lease, and ore was shipped. Other small producers were the Ridge, Dewey, Cambria, Ridgway group, and Arpad mines.

King Solomon district.—The operators of the Dives and Shenandoah No. 3 mines continued shipments from this district.

Eureka district.—The production of the Gold King Consolidated Mines Company, at Gladstone, was below that of 1907. In June, 1908, the upper terminal of the tramway and other surface buildings were burned, and the mill only commenced running in October. The Gold Prince mine and mill were in the hands of a receiver during the entire year and made no production. The Sunnyside Mines and Mill Company made an increased production. The Martin Gold Mining and Power Company, operating the Tom Moore, did considerable development work, and shipped lead-silver and zinc ores during the year. Small shipments were made from the Minnehaha and Tantallon mines.

The Kittimac Mines Company is developed by 2 tunnels, one 1,000 feet long and the other 1,500 feet. The company completed a 100-ton concentrating mill.

SAN MIGUEL COUNTY.

Mine production of gold, silver, and associated metals in San Miguel County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	119,366.09	$2,467,516	112,116.37	$2,317,651	−7,249.72	−$149,865
Silver.....do....	1,438,299	949,277	1,543,187	817,889	+ 104,888	− 131,388
Copper.....pounds..	14,905	2,981	382,402	50,477	+ 367,497	+ 47,496
Lead.....do....	5,274,641	279,556	5,555,049	233,312	+ 280,408	− 46,244
Zinc.....do....	.....	.....	952,872	44,785	+ 952,872	+ 44,785
	.....	3,699,330	.....	3,464,114	.....	− 235,216

As compared with that of 1907, the metal output of San Miguel County showed an increase in production of all the metals except gold. The total value of the metals produced, however, fell off $235,216.

The total tonnage produced from 25 deep mines was 428,231 short tons, as compared with 407,491 tons from 22 mines in 1907. The average value per ton was $8.08, as compared with $9.08 in 1907, with $10.31 in 1906, and with $9.58 in 1905. The average value per ton in gold in 1908 was $5.41, and in silver, $1.91.

The tonnage of siliceous ore amounted to 419,947 short tons, being 98 per cent of the entire tonnage. Practically all the gold and silver produced came from this class of ore. The tonnage of lead ores was 8,171 tons, and of copper ores, 113 tons.

San Miguel County in 1908 ranked second to Teller County in tonnage mined and in value of gold produced. In silver yield San Miguel was second, with Lake County first. In total value of metals produced, San Miguel County stood third, with Teller first, and Lake County second.

During 1908 there were treated at gold and silver mills (including amalgamation and cyanide mills) 419,220 short tons, or 98 per cent of all the tonnage mined; and the bullion was valued at $1,769,597 in gold, an average of $4.22 per ton, and $118,282 in silver, or an average of 28 cents per ton, a total value in gold and silver of $1,887,879, or an average value of $4.50 per ton. Therefore 60 per cent of the gold and silver produced in the county, from all sources, was recovered as bullion. From the ore treated in gold and silver mills, and from 7,640 tons sent to mills for concentration only, a total of 426,860 short tons, or 99.6 per cent of the total tonnage, there were produced 48,625 tons of concentrates, valued at $534,977 in gold, an average of $11 per ton, and $648,827 in silver, an average per ton of $13.34, a total in gold and silver of $1,183,804, and an average of $24.34 per ton.

There were produced from all milling ore $2,304,574 in gold, from both bullion and concentrates, an average of $5.40 per ton, and $767,109 in silver, or an average of $1.80 per ton, a total in gold and silver of $3,071,683, and an average of $7.20 per ton for all ore milled.

Crude ore to smelters amounted to 1,371 tons, containing $10,185 in gold, averaging $7.43 per ton; $50,744 in silver, averaging $37.01 per ton, a total in gold and silver of $60,929, and an average of $44.44 per ton.

Upper San Miguel district.—The output from this district in 1908 was 400,303 tons of ore, and $2,175,796 in gold, 1,426,458 fine ounces of silver, 333,958 pounds of copper, 4,497,029 pounds of lead, and 952,872 pounds of zinc. The total value of the production was $3,209,561. The three large mines of this district furnished over 90 per cent of the total production of the county, as was the case in 1907.

The Tom Boy Gold Mines Company (Limited) made an increased production in every metal except gold. Zinc was produced for the first time by this company. The equipment of the company's 300-ton milling plant consists of 60 stamps with plate amalgamation, twelve 6-foot Frue vanners, 15 Wilfley tables, and a roasting and magnetic separation plant.

The Smuggler-Union Mining Company increased its production over that of 1907. This company has one 80-stamp mill, and one 60-stamp mill, each with bumping tables, vanners, and concentrators, and has also 1 cyanide plant, and a canvas plant. The workings consist of 7,700 feet of tunnel, 1 shaft 670 feet deep, and another shaft 445 feet deep.

The Liberty Bell Gold Mining Company also made an increased output. The mine is opened by an adit 3,000 feet long. About 4,000 feet of drifting, 210 feet of sinking, and 2,500 feet of raising constitute the development work for 1908. The equipment of the plant consists of an 80-stamp mill, 3 tube mills for regrinding, settlers, agitators, vacuum filters, and concentrators.

The Black Bear Mining Company ran its 20-stamp concentrating mill from April throughout the year. The shaft on the mine is down 300 feet and there is an adit of 460 feet. The Gold King Consolidated mine was worked intermittently by lessees. The Contention mine was operated one month. The Kitty Mack mine was worked during part of the year. Ore from the Nellie mine was treated in the 10-stamp amalgamation mill on the property. Some ore was shipped from the Silver Chief mine. The small amalgamating plant on the Thomas property was operated for a short time. Development work on the Japan-Flora mines was reported, but the 40-ton concentration mill was not run. Development work was done on the Columbia and Champion mines by the Iowa Gold Mining Company. This company has a 20-stamp amalgamation and concentration mill.

Iron Springs district.—From this district, near Ames and Ophir, an increased tonnage was mined in 1908. From 27,086 tons were produced $128,095 in gold, 105,279 ounces of silver, 41,611 pounds of copper, and 912,765 pounds of lead, with a total value of $227,722. This was an increase, as compared with 1907, of $166,651.

The Buckeye Mining and Leasing Company, operating the Butter-fly-Terrible property, ran the mill during the entire year. An increased tonnage of lead-silver ore was shipped by the Carbonero Mines and Reduction Company, and a large tonnage was treated by the Yellow Mountain Mining Company. Other producers were the New Dominion Gold Mining Company, Suffolk Mining and Milling Company, and Massachusetts-Nevada Mining Company.

Lower San Miguel district.—This district, near Sawpit, made a small though slightly increased output in 1908. The producers were the National Mining and Milling Company and the Lizzie G. mine.

Mount Wilson district.—Lead-silver ore was shipped from the Morning Star mine, and the Mount Wilson Gold and Silver Mining Company produced concentrates in the 10-stamp concentration mill, the chief metal of which was gold. The production from these two mines made an increased output for the district as compared with 1907.

SUMMIT COUNTY.

Mine production of gold, silver, and associated metals in Summit County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	5,156.29	$106,590	9,043.27	$186,941	+ 3,886.98	+$80,351
Silver.....do....	125,847	83,059	66,025	34,993	− 59,822	− 48,066
Copper.....pounds..	21,865	4,373	28,523	3,765	+ 6,658	− 608
Lead.....do....	1,915,133	101,502	1,719,190	72,206	− 195,943	− 29,296
Zinc.....do....	3,026,627	178,571	1,232,149	57,911	−1,794,478	−120,660
	.....	474,095	.....	355,816	.....	−118,279

Summit County is the foremost placer producing area in Colorado, and in 1908 the production of the county in zinc, though small, was second only to that of Lake County.

The total metallic yield of the deep mines of the county showed in 1908 a decrease in value of over one-half, but the gold output from dredging and other placer operations increased over $100,000.

There were only 18 producing deep mines in 1908, as compared with 29 in 1907, and the tonnage sold or treated in 1908 was 14,631 short tons, as compared with 25,127 tons in 1907.

The increase in placer gold overtopped the decrease in the value of the gold from deep mines by $80,351. The decrease in silver was the result of the decreased tonnage of lead-zinc and zinc ores, the output of which fell off 8,124 tons, and to the decrease of 1,229 tons in the output of lead ores. There were slight increases in the silver derived from siliceous ore and from copper ores, but the tonnage of siliceous ore was 1,220 tons below that of 1907.

The decrease in lead output was caused entirely by the almost complete cessation of ore shipments from the Montezuma district, all the other districts making a slight gain in the production of that metal. The zinc decrease, which was the chief loss in value of metallic yield, was caused by a lessened output from the Wellington, no output whatever from the Country Boy, and a decided falling off in the yield of the mines near Kokomo.

Breckenridge district.—Breckenridge district includes Bevan, Minnesota, and Union districts.

In the Bevan district the value of the metallic production in gold, silver, lead, and zinc amounted to $114,539, a decrease of $59,289. The Dunkin Mining Company shipped considerable lead ore, carrying gold and silver. Lead carbonate and zinc sulphide ore were also shipped from the Wellington No. 3 mine. The Pitt Ores Company made shipments of gold and silver ore. The Wellington Mines Company, operating the chief mine in the district, was preparing to start its new 100-ton concentrating mill, and did not ship as large a tonnage as in 1907. The values of the ore shipped were mainly in lead and zinc.

In the Minnesota district ore was shipped from the Gold Dust, Puzzle mine and by the Senator Mining and Milling Company. The Blue Flag Gold Mining Company shipped ore and concentrates. The Reliance Gold Dredging Company operated from August to the close of the year. The Colorado Gold Dredging Company operated its dredges about six months of the year. Preparations for sluicing were made on the Snyder placer during the greater part of the year, but the run lasted only two months. Bullion from various small operators somewhat increased the placer output. During the year a dredge was moved from near Golden, and located on the Mekka placer. Dredging was not commenced until April, 1909. During the winter of 1908–9 the Reliance dredge was operated continuously. This was the first time in this district that a dredge has been operated during the winter months. The Colorado Gold Dredging Company has 3 dredges in the field, and may build 2 more. The expense of operating the dredges was considerably lessened by the entrance of two big power companies, the Central Colorado and the Summit County companies. It is expected that the big dredges can be successfully operated on the bench deposits above the present placers.

In the Union district the only shipper was the operator of the Germania mine. A short run was made by the Buffalo Placer Mining and Milling Company.

Snake River (Montezuma and Argentine) district.—The output from this district in 1908 was confined to the Fisherman Gold Mines Company, which made a small shipment.

Development was pursued on the Quail, the Colorado-Toledo, Little Jumbo, and Boer mines. The New Pennsylvania Mines Company, at Argentine, did not operate in 1908. The company has a 50-ton concentration mill.

The Vidler tunnel, cutting the divide between Clear Creek and Summit counties, reached, at the end of 1908, a distance of 4,300 feet, with about 2,200 feet remaining to connect with the western side, near Argentine.

Consolidated Ten Mile district.—This district includes Frisco, Kokomo, and Robinson. The total value of the metallic yield was one-half that of 1907.

The Excelsior mine, developed by 4 tunnels aggregating 4,000 feet, was the only producer at Frisco. A 50-ton concentration mill is on the property.

At Kokomo the production fell off heavily. Some crude ore was shipped by the Delaware Mining and Milling Company. The new Kimberly-Wilfley mill, for the separation and concentration of zinc ores, was not completed in 1908. Lead concentrates from the old mill were shipped, and crude lead ore was shipped to the smelter. Low grade zinc tailings were shipped to Denver for concentration. A large tonnage of iron ore, with values in gold and silver, for fluxing was shipped to smelters from the Michigan mine, and several cars of silver ore were shipped from the Queen of the West mine. The Utoff Tunnel Company shipped zinc ore from the ore bins. The old Wintergreen mine was reopened in 1908, and several cars of ore were shipped.

The production of the Ten Mile district for 1908 would have been very low, but for the International mine, a new producer at Robinson. The year 1907 was occupied in sinking the shaft, which in 1908 was 1,200 feet deep. The shipments were mainly of lead ore, but several cars of zinc ore were shipped to the concentrating mill at Leadville.

TELLER COUNTY.

Mine production of gold and silver in Teller County, Colo., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	527,949.61	$10,913,687	616,311.38	$12,740,287	+88,361.77	+$1,826,600.
Silver.....do....	60,397	39,862	60,736	32,190	+ 339	− 7,672
	.....	10,953,549	.....	12,772,477	.....	+ 1,818,928

Teller County (Cripple Creek mining district), in 1908, made a gross production in gold valued at $12,740,287, an increase over that of 1907 of $1,826,600. From 96 mines, there were produced 601,173

short tons of ore, not including old tailings re-treated, with an average value in gold of $20.51 per ton, as compared with 83 mines and 451,082 tons, averaging $24.28 per ton, in 1907.

The increased tonnage and the lower average value per ton was the direct result of the conditions in the camp in 1908. At no time in the history of the district have treatment and transportation charges been so advantageous as in 1908. The rates were such that $8 ore might be shipped at a profit. There was an abundance of skilled labor, and a great demand for leases. Not only were these taken on well-developed properties, but in the early months of 1908 over 100 leases were taken on old dumps. Many companies erected experimental cyanide plants for the treatment of their low-grade and dump ore, and finding them a success, undertook the handling of custom ore. There were altogether about 12 cyanide plants in the district operating more or less regularly on company and custom ore. These cyanide plants were found, in many cases, to treat profitably ores running from $2 to $4 in value.

After the desultory work of 1907, when 1,500 feet of the 15,500 feet had been driven, the contract for the Roosevelt deep drainage tunnel was awarded in January, 1908, to A. E. Carleton. Since then work has progressed steadily from the portal and also from two headings, north and south of an intermediate shaft. At the close of 1908 there had been completed in all three headings, a distance of 4,872 feet, all of it in Pike's Peak granite.

The outlying mines should be reached about January 1, 1910, and the completion is predicted for July 1, 1910. This tunnel will drain the larger part of the district at a depth of 770 feet below the present lowest tunnel, the El Paso. Many large companies have discontinued pumping and are working their upper levels only, waiting until the drainage tunnel becomes operative.

MILLS AT COLORADO CITY.

The Golden Cycle mill at Colorado City, which was burned in August, 1907, was again in operation at the beginning of 1908, with 8 Edwards roasters and a cyanide plant. Work on the new sampling mill for this plant was also begun in January, 1908. The plants of the United States Reduction and Refining Company, in Colorado City, where the ores are roasted and chlorinated and the tailings cyanided, were operated continuously throughout 1908. The Portland Gold Mining Company's mill, in Colorado City, was operated throughout the year. Another roaster was added and a plant erected for extracting the values contained in the sluice water. The capacity of the chlorination mill is 375 tons, and that of the cyanide mill 550 tons.

MILLS IN THE CRIPPLE CREEK DISTRICT.

Some of the local cyanide mills at Cripple Creek were very successful. The average gold content of the ores treated by these plants is hardly greater than $4 per ton, or 50 cents less than the lowest rate offered by the outside custom mills for freight and treatment. The Isabella 100-ton mill treated a large tonnage of oxidized low-grade ore. The Blue Flag 50-ton mill was run on minimum capacity during part of the year. The Jerry Johnson Company treated con-

siderable dump ore in its own mill. The Jo Dandy mill operated continuously until its destruction by fire, in November. The Stratton's Independence mill was run intermittently during the year. The Portland Gold Mining Company's experimental 10-stamp mill, at Victor, demonstrated that the raw ores of Cripple Creek "can be successfully treated without roasting, thus saving 76 cents per ton for roasting, and also $1 per ton freight, now paid for transporting the ore to Colorado City."

Some of the other mills in the district were the Ironclad, W. P. H., Trilby, and Wild Horse plants.

MINES REVIEW.

There were 3 mines in the Cripple Creek district, each of which produced over $1,000,000 in 1908, and 22 mines, each of which produced over $100,000.

The production of the Portland Gold Mining Company, as shown by its annual report, was 94,311 tons, having a gross value of $1,834,081, the average gross value per ton being $19.45. This company, under its own management, pursued a systematic development, in contrast to many other companies which leave the prospecting to be done by the lessees. An experimental mill was erected at the mine, and the metallurgists of the company perfected the Portland process of treating the raw, low-grade telluride ores at a low cost and advised the building of a 300-ton mill on the company's property at Victor. The company's pumping capacity on the 1,500-foot level is 850 gallons per minute, and 660 gallons per minute were pumped in 1908. The problem seems to be whether to increase the tonnage of high-grade ore by sinking to the 1,600-foot level in face of possible danger of being drowned out or to wait until the Cripple Creek drainage tunnel taps the water basin. The development and exploration work for the year amounted to 5,673 feet, bringing the grand total of the underground workings up to 212,593.5 feet, or about 40¼ miles.

The Golden Cycle Mining Company was also a large producer. This company issues no public annual statement.

The annual report of the Vindicator Consolidated Gold Mining Company showed an increase in production over that of 1907. From operations of company and lessees there were mined 33,035 tons, valued at $942,643, averaging in value $71.47 per ton. Freight and treatment cost $230,894, leaving net receipts of $711,749. The company expended a large amount on development. The shaft was sunk 200 feet below the 1,200-foot level. Large quantities of water are expected in lowering from the 1,200-foot to the 1,400-foot level. A total of 5,267 feet of development work was done, most of the work being on the 500-foot, 1,000-foot, 1,100-foot, and 1,200-foot levels.

The Elkton Consolidated Mining and Milling Company reported a prosperous year. As the result of the cut in charges for treatment, a very considerable tonnage of low-grade ore was marketed. As compared with conditions in 1907, the freight and treatment charges showed a reduction of $1.44 per ton; the average gross value per ton of the ore shipped was $8 less than in 1907, but the total shipments increased 1,648 tons. Not only were the lower-grade ore bodies

underground drawn upon, but in addition leases were given on some of the old dumps. The gross average value per ton of mine ore was $17.34, and of dump ore, $7.90. In March, 1908, the drainage of the district brought the Elkton water to a point where the 900-foot level was dry, and since that time vigorous development operations on that level have been in progress. The drainage tunnel will drain this mine to a depth of over 1,650 feet.

The El Paso Consolidated Gold Mining Company's annual report showed a largely increased production over that of 1907. The operations by lessees, of whom there were twenty-five to thirty, made a production of $423,663, with a general average value of $22 per ton. There were 4,621 feet of development work performed. The report showed that only 4 levels to a depth of 600 feet were worked. This mine will be the first to be drained by the Roosevelt tunnel. The shaft has been sunk to 7 levels and a depth of 1,000 feet.

The Stratton's Independence mine showed a great decrease in output, as compared with the production of 1907. The production was chiefly by lessees. The new mill was run at times during the year.

The Granite Gold Mining Company made a decided increase in output over that of 1907. According to that company's annual report, the operations for the year showed a gratifying improvement, though the conditions, so far as water is concerned, remained unchanged. In 1908 the mine was operated on the leasing system with satisfactory results.

The Acacia Gold Mining Company reported the depths of its shafts at 1,000 feet, 800 feet, and 350 feet. The Ajax Gold Mining Company's output was mostly from operations by lessees. The shaft on this property is down 1,200 feet. The Anchoria-Leland reported production from the upper levels by lessees. The shaft is down 1,200 feet. The Blue Flag Mining Company reported work on the 500-foot level. The Christmas mine shaft is down 1,200 feet. The Ophir mine is opened by an inclined shaft 950 feet deep. The lessee on the Cameron School Section No. 16 reported an 800-foot shaft, with 150 feet of sinking done in 1908. The 2 vertical shafts on the Dante mine are 730 feet and 520 feet deep, respectively. The shaft on the Doctor-Jack Pot is down 740 feet, and that on the Findley-Shurtloff is 1,485 feet. The output from this mine increased in 1908. The Gold Sovereign is opened by a shaft 1,000 feet deep. A vertical shaft 1,250 feet deep is reported by the Last Dollar Company. The Mary McKinney shaft is 700 feet deep. The Prince Albert Mining Company has driven a tunnel 1,000 feet long. The shaft on the property is 340 feet in depth. The Requa-Savage Gold Mining Company's vertical shaft is 600 feet in depth. A shaft 656 feet deep is on the Forest Queen mine.

Other important producers in the Cripple Creek district are the Cresson Consolidated Gold Mining and Milling Company, Isabella Mines Company, Strong Gold Mining Company, Jennie Sample Mining Company, and Stratton Cripple Creek Mining and Development Company.

The Ophir Mining and Milling Company (Dead Pine and Ophir mines), Jerry Johnson Mining Company, Gold King Mining Company, Henry Adney Mining Company, Jo Dandy Mining Company, Katinka Gold Mining Company, Moon-Anchor Mining Company, Lexington

Gold Mining Company, Mary Cashen Gold Mining Company, Mary Jane Mining Company, Modoc Mining and Milling Company, Pharmacist Mining Company, Trilby Mines Company, and Work Mining and Milling Company were also producers.

Among the mines with smaller outputs are the Black Belle, Blue Bird, Comanche Plume, Coriolanus, Enterprise, Ethel Louise, Free Coinage, Gold Hill Bonanza, Index, Julia V., Mattie L., Midget, Mohican, Morning Glory, Mountain Beauty, Old Gold, Ramona, Ruby, and Tornado.

IDAHO.

By C. N. Gerry.

PRODUCTION.

The combined value of the production of gold, silver, copper, lead, and zinc in Idaho in 1908 was $15,416,599; the corresponding value in 1907 was $21,793,064—a decrease in 1908 of $6,376,465, or over 29 per cent. Since, for three years prior to 1907, Idaho increased the value of its metal output at the rate of nearly $3,000,000 per year, it can readily be seen what a serious effect was wrought by the panic of 1907. There were in all 385 producing mines in 1908, of which 207 were placers. Although the number of producing mines increased, so many of them were worked on a small scale that the results fell short of the usual production. The value of the gold and silver production was $5,402,549, which was less by $1,407,547 than that of 1907. The total tonnage of the State was 1,689,231 short tons, which was slightly less than for 1907; but as this tonnage was valued at only $15,129,532, the average value per ton decreased from $12.68 to $8.96. The value per ton in gold and silver fell from $3.82 to $3.03.

A summary of the reduction plants in Idaho reveals the fact that out of approximately 182 mills and smelters 6 were recently completed, 119 were idle, and 57 were in operation during the whole or part of the year. Of the 57 in operation, 2 were smelters, one at Ponderay and the other at Ivers; 13 were concentrators of lead-silver ore; and 45 were gold and silver mills, of which not more than 7 were in operation the greater part of the year. In these gold and silver mills 125,401 tons of ore were treated, yielding 38,603.97 ounces of gold and 378,480 ounces of silver, at an average recovery per ton of $6.36 for the former and of 3.02 ounces for the latter. The most important counties supplying this yield were Owyhee, Elmore, Boise, Idaho, and Custer. There were 1,200,579 tons of ore treated at concentration mills, which, at the ratio of 6.54 to 1, made 183,459 tons of concentrates, with an assay value of $10,047,743. The average content in gold and silver was 84 cents and 27.30 ounces, respectively. The crude ore shipped direct to smelters amounted to 147,021 tons, with an assay value of $4,083,179, the average of which was $1.22 in gold and 14.15 ounces in silver. The statement of production for 1907 and 1908, showing increase and decrease and values at each year's average commercial prices, is as follows.

Mine production of gold, silver, and associated metals in Idaho in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−)	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	60,754.70	$1,255,911	69,827.33	$1,443,459	+ 9,072.63	+ $187,548
Silver.....do....	8,415,431	5,554,185	7,469,981	3,959,090	− 945,450	−1,595,095
Copper.....pounds..	10,890,731	2,178,146	10,041,850	1,325,524	− 848,881	− 852.622
Lead.....do....	233,823,854	12,392,664	206,827,816	8,686,768	−26,996,038	−3,705,896
Zinc.....do....	6,985,732	412,158	37,410	1,758	− 6,948,322	− 410,400
	.....	21,793,064	.....	15,416,599	.....	−6,376,465

Of the tonnage, more than 86 per cent was of lead ore, largely from the Coeur d'Alene region, the gold and silver value of which was only $2.19 per ton. There was an increase in this kind of ore of 73,697 tons, but the metallic contents were not as high as in recent previous years, due to the treatment in 1908 of a large tonnage of old tailings. More than 6 per cent of the tonnage was copper ore, derived largely from Shoshone and Custer counties. This portion of the tonnage contained an average value of $4.68 in gold and silver per ton, and decreased from 136,327 tons in 1907 to 107,400 tons in 1908, a decrease traceable to the inactivity of the first part of 1908. Siliceous ore, yielding $11.34 per ton in gold and silver, represented 7.43 per cent of the tonnage and increased from 93,238 tons in 1907 to 125,657 tons in 1908. This striking increase is credited largely to Elmore County, but was also partly from Custer, Boise, Owyhee, and Idaho counties. Small quantities of zinc ore and copper-lead ore were produced, and there was a decided falling off in lead-zinc ore, amounting to 78,814 tons, due principally to the idleness of the Success mine near Wallace.

GOLD.

The gold output of the State increased from 60,754.70 ounces in 1907, valued at $1,255,911, to 69,827.33 ounces, valued at $1,443,459, in 1908. The increase of 9,072.63 ounces in quantity and of $187,548 in value was made by the deep mines alone, since there was a decrease in placer production. Sixty-five per cent of the gold was derived from siliceous ore, and gold from this source increased from 34,409.04 ounces in 1907 to 45,417.29 in 1908, owing to the activity at Atlanta, Sunbeam, Quartzburg, Silver City, and Elk City. Placers produced nearly 20 per cent of the gold output, amounting to 13,817.98 ounces, valued at $285,643, a decrease of 3,447.30 ounces. Gold in copper ore, supplying 11.67 per cent of the total, increased from 5,894.26 to 8,152.32 ounces, largely from the operation of the Lost Packer smelter in Custer County. The only other source of gold of importance was lead ore, which yielded 3,113.52 ounces in 1907, but only 2,439.24 ounces in 1908. Gold from lead ore represented 3.49 per cent of the State total. Seven counties produced 94 per cent of the gold. In order of their production, they were as follows: Owyhee, Custer, Boise, Idaho, Elmore, Shoshone, and Lemhi. Placer gold, which is won mostly by hydraulic and sluicing methods, amounted to $285,643. Boise County was the largest producer, with Nez Perce, Idaho, Lemhi, and Shoshone supplying important amounts. There

were decreases in Boise, Nez Perce, and Shoshone. The output from dredging operations was slightly in excess of that of 1907, and amounted to 3,734.04 ounces, which output will probably be increased in the near future, as new dredges are to operate at Pierce, Stanley, and Elk City. There are 163 gold and silver mills in Idaho, many of which, however, are old; a large number were built before a sufficient amount of ore was developed, and others are unsuited to the present treatment of ore, which accounts in part for the idleness of 116 of them in 1908. The 45 active mills produced bullion containing gold valued at $798,015 and 1,163 tons of concentrates, which contained an average per ton of $112.65 in gold, or a total value of $130,931. Lead concentrates contained $49,235 in gold, or 27 cents per ton; and crude ore supplied $179,645 in gold, an average of $1.22 per ton.

Source of gold production in Idaho, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Total.
Ada	68.31	220.88					289.19
Bingham	293.68		3.73				297.41
Blaine	63.32	7.07	.48	56.36			127.23
Boise	5,698.96	3,942.51					9,641.47
Bonner		6.10	.49	1.20			7.79
Canyon	37.93						37.93
Cassia				23.80			23.80
Custer	227.60	5,593.40	7,842.28	5.57		0.09	13,668.94
Elmore	237.62	7,145.42					7,383.04
Fremont			.30	.47			.77
Idaho	2,064.64	7,268.54					9,333.18
Kootenai and Latah	204.39						204.39
Lemhi	1,730.86	1,775.06	.65	9.00		.42	3,515.99
Lincoln	45.42						45.42
Nez Perce	2,185 53						2,185.53
Oneida	213.43						213.43
Owyhee	54.42	18,807.62		.10			18,862.14
Shoshone	584.47	650.69	300.18	2,342.74			3,878.08
Twin Falls	107.39						107.39
Washington			4.21				4.21
	13,817.98	45,417.29	8,152.32	2,439.24		.51	69,827.33

Mine production of gold in Idaho in 1907 and 1908, by kinds of ore, in fine ounces.

Year.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Lead-zinc ore.	Copper-lead ore.	Total.
1907	17,265.28	34,409.03	5,894.26	3,113.52	72.60		60,754.70
1908	13,817.98	45,417.29	8,152.32	2,439.24		0.51	69,827.33
Increase (+) or decrease (−)	−3,447.30	+11,008.26	+2,258.06	−674.28	−72.60	+.51	+9,072.63

SILVER.

The production of silver amounted to 7,469,981 ounces, which, at the average price per ounce of 53 cents, was valued at $3,959,090. This is a decrease of 945,450 ounces in quantity and of $1,595,095 in value from the output of 1907. Shoshone County supplied 85 per cent of the total; Owyhee, 11.47 per cent; Blaine, 1.69 per cent; and Custer, Bonner, and Lemhi each less than one-half of 1 per cent. From the lead ores, most of which are mined in the Coeur d'Alene region, 5,917,034 ounces were derived, or over 79 per cent of the total.

Copper ores supplied over 8 per cent and siliceous ores over 12 per cent; the insignificant remainder came from placers and copper-lead ore. There were increases in silver from siliceous ore and copper ore, but a large decrease from lead ore and lead-zinc ore. The decrease in silver from lead ore, 900,805 ounces, was the result of the low prices of lead and silver, which closed some of the mines and concentrators of the lead-silver district of Shoshone County. Two-thirds of the total production, or 5,008,735 ounces, came from concentrates, which averaged more than 27 ounces per ton. This amount represented both concentrates from gold-silver mills, 1,163 tons containing 500,357 ounces, or 430 ounces per ton, and lead concentrates, 182,296 tons, containing 4,508,378 ounces, or 24.73 ounces per ton. Crude ore, averaging 14.15 ounces per ton, furnished 2,080,079 ounces, or nearly 28 per cent, and gold and silver bullion contained 378,480 ounces, or 5 per cent of the total, and an average of 3.02 ounces per ton. Of 178 deep mines, there were 72 which produced gold and silver.

Source of silver production in Idaho, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	30	164					194
Bingham	13		31				44
Blaine	11	852		125,463			126,326
Boise	1,273	5,756					7,029
Bonner		29,547	2,620	1,280			33,447
Canyon	9						9
Cassia				186			186
Custer	88	6,318	19,726	11,754	429		38,315
Elmore	69	7,066					7,135
Fremont			16	432			448
Idaho	339	9,568					9,907
Kootenai and Latah	23						23
Lemhi	167	1,055	30	21,264	476		22,992
Lincoln	3						3
Nez Perce	530						530
Oneida	14						14
Owyhee	15	857,394		128			857,537
Shoshone	98	374	607,553	5,756,527			6,364,552
Twin Falls	5						5
Washington			1,285				1,285
	2,687	918,094	631,261	5,917,034	905		7,469,981

Mine production of silver in Idaho in 1907 and 1908, by kinds of ore, in fine ounces.

Year.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
1907	3,518	843,077	536,007	6,817,839		214,990	8,415,431
1908	2,687	918,094	631,261	5,917,034	905		7,469,981
Increase (+) or decrease (−)	−831	+75,017	+95,254	−900,805	+905	−214,990	−945,450

COPPER.

The production of copper decreased from 10,890,731 pounds in 1907 to 10,041,850 in 1908, a difference of 848,881 pounds in quantity and of $852,622 in value, the average price per pound being 13.2 cents in 1908 against 20 cents in 1907. Ninety per cent of the copper came from Shoshone County. This was derived from the Snowstorm copper mine and from other mines of the Coeur d'Alene region which contain

small quantities of copper in lead ores. The decrease in the State total was the result of the inactivity of the smelter at Mackay, in Custer County, for the operators of the Lost Packer mine shipped more matte than in the past, and the Snowstorm mine greatly increased the production of siliceous copper ore. Washington, Blaine, Bonner, and Lemhi counties were the only others that yielded important amounts of copper.

LEAD.

A decrease in lead even greater than that of 1907 was recorded for 1908, when the production fell from 233,823,854 pounds, valued at $12,392,664, to 206,827,816 pounds, valued at $8,686,768. The average price for the year was 4.3 cents. This decrease of 26,996,038 pounds in quantity and of $3,705,896 in value was almost entirely due to the curtailment of the output of the Coeur d'Alene region on account of the low price of lead. There were, however, decreases in other counties for the same reason. Shoshone County yielded over 98.7 per cent of the total. Blaine, Lemhi, and Custer counties followed with smaller outputs. With better prices Blaine County might be expected to return to the output of former years, since several new concentrators were completed in 1908.

ZINC.

The only zinc ore shipped in 1908 was a small production from Blaine County. The output decreased from 6,985,732 pounds, valued at $412,158, in 1907 to 37,410 pounds, valued at $1,758, in 1908. The average price per pound was 4.7 cents. The Success and Frisco mines, from which were shipped much ore and concentrate in 1907, were idle in 1908.

MINING INDUSTRY IN IDAHO IN 1908.

Although prices for metals were low and many of the mines and smelters curtailed their output, several new reduction works were completed, and much development work was accomplished in 1908. In Elmore and Custer counties quartz mines were actively worked, and the bullion shipments from the Buster mine at Elk City, from the mine of the Bagdad-Chase Company at Atlanta, and from the Golden Sunbeam at Sunbeam have been notable. In Shoshone County the Hecla mine at Burke and the Morning mine at Mullan were idle six months, and the Last Chance at Wardner two months. The remaining four regular producers—Bunker Hill and Sullivan, Standard-Mammoth, Hercules, and Snowstorm—were operated the entire year. The Tiger-Poorman, up to this time one of the large producers, was considered exhausted, and development below the 2,200-foot level was not continued. The operators of the Bunker Hill and Sullivan, the largest producer in the State, started the construction of an additional concentrator, which will eventually have a daily capacity of 1,000 tons. After repairs and improvements in the original mill, the combined capacity will be 2,000 tons. The Star mine at Mullan made a good showing. Other important mines are the Caledonia, at Wardner; the Bear Top, east of Murray; the Ambergris, near the Hercules; the Cooney mine, at Burke; and the Alice, several miles east of Wallace. The first of the year witnessed the operation of the Idaho

Northern Railroad from Enaville to Murray. This will doubtless bring the North Side mine into prominence as a shipper of lead-silver ore. Definite assurances were made that the Armstead and Gilmore Railroad would be built in the near future from Armstead, Mont., to Gilmore, Idaho, and thence to Salmon City. That part of the road from Gilmore to Armstead, 68 miles, will probably be constructed first, as the largest mine of the county, the property of the Pittsburg-Idaho Company, Limited, and other mines of the Texas and Spring Mountain districts, will thus be saved a haul of 80 miles. The remaining 75 miles of railroad from Gilmore to Salmon will, when completed, stimulate gold mining in that locality. The Chicago, Milwaukee and St. Paul Railroad, part of which was being constructed through Taft, Mont., to St. Joe, Idaho, will provide transportation to mines and prospects south of the Coeur d'Alene region. Construction work was continued on the road from Huntington to Lewiston, which should offer transportation facilities to many mines in the western side of the State, but particularly to those of the Seven Devils district. The line is completed from Huntington to Homestead, 58 miles north. At the new town of Hahn, in the Spring Mountain district of Lemhi County, work was started on a 100-ton custom lead smelter by the Lemhi Smelting Company. There are many mines in the vicinity which will be able to supply lead-silver ore. The Lost Packer Mining Company operated its 100-ton matting plant for three months in 1908 and shipped an unusually large product east for refining. The Idaho Smelting and Refining Company operated the 150-ton lead smelter at Ponderay from October 30 to the end of the year. The plant not only treated ores from Washington and Montana, but from the mines in the vicinity of Lake Pend d'Oreille. The smelter at Mackay was idle during the entire year. Two new dredges were installed in 1908, 1 in Boise Basin and 1 in Stanley Basin, and 3 others may be erected at Pierce, Elk City, and in Boise County. Four new concentrators were completed in Blaine County, 2 gold and silver mills in Lemhi County, and 2 in Owyhee County.

Mine production of gold, silver, copper, lead, and zinc in Idaho, in 1908, by counties.

County.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Pounds.*	
Ada	289.19	$5,978	194	$103		
Bingham	297.41	6,148	44	23	1,993	$263
Blaine	127.23	2,630	126,326	66,953	31,941	4,216
Boise	9,641.47	199,307	7,029	3,725	198	26
Bonner	7.79	161	33,447	17,727	15,006	1,981
Canyon	37.93	784	9	5		
Cassia	23.80	492	186	98	208	28
Custer	13,668.94	282,562	38,315	20,307	815,382	107,630
Elmore	7,383.04	152,621	7,135	3,782		
Fremont	.77	16	448	237		
Idaho	9,333.18	192,934	9,907	5,251	233	31
Kootenai and Latah	204.39	4,225	23	12		
Lemhi	3,515.99	72,682	22,992	12,186	10,366	1,368
Lincoln	45.42	939	3	2		
Nez Perce	2,185.53	45,179	530	281		
Oneida	213.43	4,412	14	7		
Owyhee	18,862.14	389,915	857,537	454,495		
Shoshone	3,878.08	80,167	6,364,552	3,373,212	9,042,876	1,193,660
Twin Falls	107.39	2,220	5	3		
Washington	4.21	87	1,285	681	123,647	16,321
	69,827.33	1,443,459	7,469,981	3,959,090	10,041,850	1,325,524

Mine production of gold, silver, copper, lead, and zinc in Idaho, in 1908, by counties—Continued.

County.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Ada					$6,081
Bingham					6,434
Blaine	1,675,124	$70,355	37,410	$1,758	145,912
Boise	13,596	571			203,629
Bonner	5,077	213			20,082
Canyon					789
Cassia	6,923	291			909
Custer	226,332	9,506			420,005
Elmore					156,403
Fremont	61,436	2,580			2,833
Idaho					198,216
Kootenai and Latah					4,237
Lemhi	700,622	29,426			115,662
Lincoln					941
Nez Perce					45,460
Oneida					4,419
Owyhee	288	12			844,422
Shoshone	204,138,418	8,573,814			13,220,853
Twin Falls					2,223
Washington					17,089
	206,827,816	8,686,768	37,410	1,758	15,416,599

Tonnage of ore sold or treated, number of mines producing, and tenor of ores in Idaho, in 1907 and 1908, by counties.

County.	Total tonnage of ore sold or treated.		Deep mines producing.		Total average value per ton.		Average value per ton in gold and silver.		Total value of deep mines.
	1908.	Increase (+) or decrease (−).	1907.	1908.	1907.	1908.	1907.	1908.	
	Short tons.	*Short tons.*							
Ada and Bear Lake[a]	393	+ 167	5	4	$26.93	$11.84	$25.85	$11.84	$4,653
Bingham	7		1	1	70.14	50.85	13.71	13.28	356
Blaine	7,753	− 7,076	22	37	18.08	18.65	9.41	8.81	144,597
Boise	15,854	+ 7,485	18	17	9.80	5.37	9.50	5.33	85,146
Bonner	197	+ 98	5	8	74.58	101.93	72.66	90.80	20,082
Canyon									
Cassia	10	− 4	1	2	94.21	90.90	41.21	59.00	909
Custer	18,947	−25,475	11	20	19.75	21.92	5.07	15.73	415,254
Elmore	24,261	+17,528	10	12	13.89	6.24	13.89	6.24	151,455
Fremont	86	− 884	2	3	47.09	32.94	1.14	2.94	2,833
Idaho	15,778	+ 2,351	17	17	5.36	9.85	5.31	9.84	155,356
Kootenai and Latah									
Lemhi	2,515	−10,012	18	19	15.80	31.73	6.79	19.48	79,794
Lincoln									
Nez Perce		− 3	1		88.00		88.00		
Oneida									
Owyhee	51,491	+ 4,471	9	7	18.70	16.38	18.68	16.38	843,289
Shoshone	1,551,680	+10,010	23	28	12.24	8.51	3.15	2.22	13,208,719
Twin Falls									
Washington	259	− 285	2	3	58.39	65.98	5.57	3.96	17,089
	1,689,231	− 1,629	145	178	12.68	8.96	3.82	3.03	15,129,532

[a] Bear Lake County was not a producer in 1908.

Tonnage of milling and smelting ore and concentrates, with metallic contents, produced in Idaho in 1908, by counties.

County.	Ore to gold and silver mills.			Quantity of ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Ada	389	93.44	50	.....
Bingham	.....	.....	.....	.....
Blaine	8	4.06	4	3,336
Boise	15,839	3,271.76	1,538	.....
Bonner	.....	.....	.....	.....
Cassia	.....	.....	.....	.....
Custer	14,866	5,468.85	5,655	42
Elmore	24,208	6,103.32	5,504	.....
Fremont	.....	.....	.....	.....
Idaho	15,773	5,505.61	1,653	.....
Lemhi	1,812	1,659.73	553	.....
Nez Perce	.....	.....	.....	.....
Owyhee	51,483	16,111.66	363,467	.....
Shoshone	1,023	385.54	56	1,197,201
Washington	.....	.....	.....	.....
Total	125,401	38,603.97	378,480	1,200,579
Per ton	.....	0.3078	3.02	.....

County.	Concentrates produced.						Total value of concentrates.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
Ada	22	112.96	95	.....	.....	.....	$2,385
Bingham	.....	.....	.....	.....	.....	.....	.....
Blaine	1,082	12.61	58,236	7,515	580,042	.....	56,480
Boise	413	617.58	4,034	198	11,337	.....	15,407
Bonner	.....	.....	.....	.....	.....	.....	.....
Cassia	.....	.....	.....	.....	.....	.....	.....
Custer	19	124.76	1,499	420	19,180	.....	4,235
Elmore	153	1,021.30	1,548	.....	.....	.....	21,932
Fremont	.....	.....	.....	.....	.....	.....	.....
Idaho	395	1,757.87	6,050	.....	.....	.....	39,545
Lemhi	5	12.82	27	45	3,640	.....	438
Nez Perce	.....	.....	.....	.....	.....	.....	.....
Owyhee	170	2,686.22	487,940	.....	.....	.....	314,137
Shoshone	181,200	2,368.92	4,449,306	65,237	170,892,167	.....	9,593,184
Washington	.....	.....	.....	.....	.....	.....	.....
Total	183,459	8,715.04	5,008,735	73,415	171,506,366	.....	10,047,743
Per ton	.....	0.0475	27.30	.....	.....	.....	.....

Crude ore shipped to smelters from Idaho in 1908, by counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
Ada	4	14.50	19	.....	.....	.....	$310
Bingham	7	3.73	31	1,993	.....	.....	355
Blaine	1,409	47.24	68,075	24,426	1,095,082	37,410	88,033
Boise	15	53.17	184	.....	2,259	.....	1,292
Bonner	197	7.79	33,447	15,006	5,077	.....	20,082
Cassia	10	23.80	186	208	6,923	.....	910
Custer	4,039	7,847.73	31,073	814,962	207,152	.....	294,971
Elmore	3	20.80	14	.....	.....	.....	437
Fremont	86	.77	448	.....	61,436	.....	2,833
Idaho	5	5.06	1,865	233	.....	.....	1,124
Lemhi	703	112.58	22,245	10,321	696,982	.....	44,752
Nez Perce	.....	.....	.....	.....	.....	.....	.....
Owyhee	8	9.84	6,115	.....	288	.....	3,456
Shoshone	140,276	539.15	1,915,092	8,977,639	33,246,251	.....	3,607,535
Washington	259	4.21	1,285	123,647	.....	.....	17,089
Total	147,021	8,690.37	2,080,079	9,968,435	35,321,450	37,410	4,083,179
Per ton	.....	0.0591	14.15	.....	.....	.....	.....

Subdivision of tonnage of ore sold or treated in Idaho in 1908, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.
Ada	393					
Bingham		7				
Blaine	17	66	7,607	63		
Boise	15,854					
Bonner	114	63	20			
Canyon						
Cassia			10			
Custer	14,866	3,814	264		3	
Elmore	24,261					
Fremont		32	54			
Idaho	15,778					
Kootenai and Latah						
Lemhi	1,821	22	660		12	
Nez Perce						
Oneida						
Owyhee	51,490		1			
Shoshone	1,063	103,137	1,447,480			
Twin Falls						
Washington		259				
Total	125,657	107,400	1,456,096	63	15	
Value per ton in gold and silver	$11.34	$4.68	$2.19		$32.68	

Mine production of placer gold in Idaho in 1907 and 1908, by counties.

County.	1907.	1908.	County.	1907.	1908.
Ada	$2,095	$1,412	Lemhi	$32,474	$35,780
Bingham	7,713	6,071	Lincoln	502	939
Blaine	49	1,309	Nez Perce	54,211	45,179
Boise	166,210	117,808	Oneida	8,784	4,412
Canyon	306	784	Owyhee	1,368	1,125
Cassia	870		Shoshone	17,231	12,082
Custer	8,588	4,705	Twin Falls	2,272	2,220
Elmore	4,150	4,912	Washington	32	
Idaho	40,600	42,680			
Kootenai and Latah	9,450	4,225		356,905	285,643

Gold production of Idaho placers by different methods, 1907 and 1908.

		Hydraulic.[a]	Drift.	Dredge.	Total.
1907	fine ounces	13,404.27	260.05	3,600.96	17,265.28
1908	do	10,030.23	53.71	3,734.04	13,817.98

[a] Includes sluicings.

In 1908 there were 385 producing mines in Idaho, of which 207 were placers and 178 were deep mines. Of the placers 197 were worked by hydraulicking, 5 were dredging operations, and 5 were drift mines. Of the deep mines 1 was a gold mine, and 1 a silver mine; 72 were gold-silver, 12 were gold-silver-copper, 24 were gold-silver-copper-lead, 46 were gold-silver-lead, and 15 were silver-lead mines; 1 was a silver-copper-lead, 1 a silver-copper, and 1 a zinc mine; and 4 were copper mines.

REVIEW BY COUNTIES.

ADA COUNTY.

In 1908 Ada County produced 289.19 ounces of gold and 194 ounces of silver, the total value of both being $6,081, which was $1,853 less than it was in 1907. The Gold Eagle is the only mine of the county which has made a large production in the last five years.

Black Hornet district.—A small output of ore from shallow workings was milled by the Last Hope Mining Company in a 3-stamp amalgamation mill. Other properties under development in the district were the June, the Three Links, and the Twentieth Century.

Highland Valley district.—Southeast of Boise City, near the Elmore County line, placer gold was mined from along Boise River. Production was reported from the Red Rock Placer.

McIntyre district.—The Celtic Gold Mining Company continued the development of property 5 miles east of Boise. A 1,300-foot tunnel is said to disclose 3 distinct veins. Bullion was produced through the operation of a 5-stamp mill and cyanide plant. Streaks of high-grade ore were found, but the ore is reported to average $4 per ton. At the Picket Pin mine the development consists of a tunnel now 380 feet long. Part of the ore is free-milling; some of it contains the sulphides of iron, lead, and zinc. It occurs in fissures in granite, and is said to average about $5 per ton.

Neal district.—The greater part of the Neal district is in Elmore County, but the Gold Eagle mine is in Ada County. This was operated a short time in 1908, and bullion and concentrate were shipped. The mine is developed by over 4,000 feet of tunnels and shafts, 300 feet of which was accomplished in 1908. The equipment consists of a 20-stamp amalgamation and concentration mill.

Shaw Mountain district.—The Big Giant Gold Mining Company, which owns property in both Ada and Boise counties, has a deposit of low-grade ore, developed by 1½ miles of underground openings. The vein is said to be 50 feet wide and to average $4 in gold per ton. It is thought that the ore may be successfully treated by the cyanide process.

BANNOCK COUNTY.

Fort Hall district.—The Fort Hall Mining Company continued the development of the low-grade ore zone cut by the tunnel at 3,55[illegible] feet and made concentration tests on its ores, but no shipments were made. The Papoose Company, whose property adjoins the Fort Hall, extended its tunnel.

BEAR LAKE COUNTY.

There were no shipments from the county and no extensive development work was reported.

BINGHAM COUNTY.

The output, largely from placers at Gray and points along the Snake River, amounted to 297.41 ounces of gold, 44 ounces of silver and 1,993 pounds of copper, valued at $6,434.

Mount Pisgah district.—The American Hydraulic Placer Mining Company, whose mine is situated east of Gray's Lake, continued productive work in 1908. The Caribou Gold and Copper Company made small shipments of copper ore.

Snake River district.—Sluicing operations on the banks of Snake River, near Blackfoot and Otis, produced $2,717 in gold. The Woodruff Bar was the largest producer.

BLAINE COUNTY.

Mine production of gold, silver, and associated metals in Blaine County, Idaho, in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
DEEP MINES.						
Gold.....fine ounces.	1,308.74	$27,054	63.91	$1,321	−1,244.83	−$25,733
Silver.....do....	170,358	112,436	126,315	66,947	− 44,043	− 45,489
Copper.....pounds.	35,919	7,184	31,941	4,216	− 3,978	− 2,968
Lead.....do....	2,250,164	119,259	1,675,124	70,355	− 575,040	− 48,904
Zinc.....do....	37,077	2,187	37,410	1,758	+ 333	− 429
PLACERS.						
Gold.....fine ounces.	2.37	49	63.32	1,309	+ 60.95	+ 1,260
Silver.....do....	9	6	11	6	+ 2	.....
	.....	268,175	.....	145,912	.....	−122,263

Source of gold and silver in Blaine County, Idaho, in 1907 and 1908, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Siliceous ore.	Lead ore.	Copper ore.	Lead-zinc ore.	Total.
Gold	1907	2.37	865.81	442.92	.....	.....	1,311.10
	1908	63.32	7.07	56.36	0.48	.....	127.23
Silver	1907	9.00	3,945.00	166,396.00	17.00	.....	170,367.00
	1908	11.00	852.00	125,463.00	.....	.....	126,326.00

The total value of the county output in 1908 amounted to $145,912. This was distributed as follows: Gold, 127.23 ounces; silver, 126,326 ounces; copper, 31,941 pounds; lead, 1,675,124 pounds; and zinc, 37,410 pounds. There were 37 mines from which shipments were made, but there were only 6 properties from which more than 100 tons were shipped. The Wood River district averaged a car of ore or concentrates every other day, but the mills, with a combined capacity of 900 tons, were almost entirely idle. Although the production for 1908 was small, the outlook at the end of the year was better than for many years past on account of the building of new mills and electric power plants. Mills aggregating 400 tons in capacity were in course of construction on the Croesus, Boston-Idaho, Independence, and Muldoon properties, and the 250-ton plant of the Idaho Consolidated was completed.

The principal product is lead ore, although gold-bearing ore was an important factor in the production of 1907. There were 7,753

tons of crude and concentrating ore produced in 1908, which was about half of the output of 1907, and which averaged $18.65 per ton. This tonnage represented 1,409 tons of crude ore shipped, valued at $88,033, or at $62.48 per ton; and 6,344 tons of ore which made 1,082 tons of concentrates, valued at $56,480, or at $52.20 per ton. The Wood River region contains 5 mining districts, of which the principal are the Mineral Hill and Warm Springs districts. As there is a Little Wood River district east of Hailey, near Muldoon, and a Wood River district in the vicinity of Galena, northwest of Ketchum, references to the Wood River country are often confusing.

Antelope district.—On Lead Belt Gulch, a tributary of Antelope Creek, northeast of Muldoon, the Antelope Mining Company (Limited) operated the Climax and the Silver King claims, upon which 1,030 feet of development has been accomplished and from which several shipments of silver-lead ore were made during the year.

Dome district.—On Little Lost River ore was shipped from the Belknap and Wilbert mines. The former is a copper prospect, and the latter a lead-silver mine which was operated eight months of the year.

Hamilton district.—Near Clyde, on Little Lost River, copper ore was shipped from the Automatic group of the Copper and Uranium Mining Company. Operators of the old Frank mine in the same locality made shipments to Salt Lake City of a good grade of lead ore containing silver.

Lava Creek district.—Small lots of lead ore were shipped from the St. Louis and Iron Mountain mines near Martin. The Crystal Carbonate mine has a tunnel 780 feet long, and the Paymaster about 800 feet of work.

Little Smoky district.—Twenty miles west of Hailey the Cannon Ball Mining and Milling Company developed a gold property of 3 claims with 425 feet of tunnels. A small amount of bullion was produced through the operation of a 5-stamp mill.

Little Wood River district.—Although there were no shipments from this district in 1908 there was important development and construction work in progress, and the district will probably ship lead ore and concentrate in 1909. At the Muldoon mine 1,000 feet of work was done in 1907 and 1908. The mine is said to contain much second-class ore left by the old company, as well as ore of shipping grade recently disclosed. A 100-ton concentration mill was erected during 1908 and a 300-horsepower hydro-electric power plant constructed. The management of the Muldoon property is also operating the Mutual and Mountain Bell mines, upon which much work has been done. An ore body 12 feet in width was reported opened on the property of the Idaho Mines Development Company.

Mineral Hill district.—In this, the principal district, 21 mines supplied 6,973 tons of ore, containing $1,657 in gold, 102,519 ounces of silver, 10,305 pounds of copper, and 1,247,711 pounds of lead. Four years ago the ore produced in the district was valued at five times that of this output. The production will doubtless be increased when the new mills of the Idaho Consolidated Mines Company (Limited) and of the Croesus Gold and Silver Mining Company are in successful operation. The former company owns the Minnie Moore mine, which for many years has been the largest producer of the

district. During 1908 a new 250-ton concentration plant was completed at this mine, half of which is equipped with the usual wet concentration tables, the remainder consisting of tables for dry concentration. The mill was operated for three months in 1908 on old tailings, but results were not thoroughly satisfactory and improvements will be made. The company is said to have 150,000 tons of old tailings, containing zinc, silver, and lead. During the year a new 1,200-horsepower hydro-electric power plant was completed. An incline shaft on the Relief claim, which intersects 2 new veins, is to tap the 800-foot level from the Minnie Moore shaft. Both these shafts were in process of being unwatered, not only preparing the way for production, but draining other properties of the district. Four miles west of Hailey, the Croesus Gold and Copper Mining Company has completed its 120-ton concentration mill, which is to be supplied with power by the Cramer Electric Company. The equipment consists of crusher rolls, jigs, Huntington mills, tables, and amalgamation plates. The incline shaft, now down about 850 feet, is reported to show a vein of iron and copper sulphides from 8 to 10 feet wide. At the 600-foot level a lead-silver vein cuts this ore body. This mine should be an important producer in 1909, as it was in 1907. The 5 largest producers of the district were the Eureka, the Quincy Junior, the Idaho Consolidated, the Climax, and the Nay Aug, from all of which was shipped lead ore or concentrates containing silver and a little copper and gold. The mills on the Quincy Junior and Eureka were operated. The Nay Aug mine, of the Wood River Zinc Company, is opened by 3 tunnels, the deepest being 2,000 feet long. Work aggregating 1,110 feet was done in 1908. Other producers of the district were the Idaho-Democrat, Hard Times, Hidden Treasure, Jay Gould, Monarch, Red Elephant, Bullion, Harrison, Black Barb, and North Star.

Soldier district.—The Hailey Mines Development Company, operating the Five Points mine near Soldier, is said to have developed an ore body of some importance.

Warm Springs district.—Nine producers near Ketchum contributed 227 tons of ore, yielding $314 in gold, 11,655 ounces of silver, 90,856 pounds of lead, and 37,410 pounds of zinc, with a total value of $12,065. The shippers were the Alabama-Idaho, Lucky Boy, Silver Fortune, Independence, Carbonate Hill, New Hope, Sampson, Noon Day, and Big Bonanza. During 1908 the Boston-Idaho Mining Company bought the Lucky Boy group of 8 claims, from which much zinc ore was shipped in 1905. The company owns a 30-ton concentrator and is preparing to install a larger mill. An aerial tramway transports ore from mine to mill. Only a small quantity of zinc ore was marketed in 1908. The Independence Mining Company, on the East Fork of Wood River, nearly completed its new 100-ton mill by the end of the year. The mine should make an important output in 1909. The Cramer Electric Company will supply the power, the necessary transmission line, 14 miles long, having been completed.

BOISE COUNTY.

Mine production of gold, silver, and associated metals in Boise County, Idaho, in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
DEEP MINES.						
Gold.....fine ounces..	3,341.07	$69,066	3,942.51	$81,499	+ 601.44	+$12,433
Silver.....do....	15,785	10,418	5,756	3,050	− 10,029	− 7,368
Copper.....pounds..	.....	.....	198	26	+ 198	+ 26
Lead.....do....	47,903	2,539	13,596	571	− 34,307	− 1,968
PLACERS.						
Gold.....fine ounces..	8,040.41	166,210	5,698.96	117,808	−2,341.45	− 48,402
Silver.....do....	1,768	1,167	1,273	675	− 495	− 492
	.....	249,400	.....	203,629	.....	− 45,771

Source of gold and silver in Boise County, Idaho, in 1907 and 1908, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Siliceous ore.	Total.
Gold	1907	8,040.41	3,341.07	11,381.48
	1908	5,698.94	3,942.53	9,641.47
Silver	1907	1,768	15,785	17,553
	1908	1,273	5,756	7,029

The value of the output of this county, almost entirely of gold, amounted to $203,629, or $45,771 less than in 1907. There were 57 producers in 1908, of which 40 were placers, and 17 produced gold and silver from deep mines. The county was third in output of gold, and produced 9,641.47 ounces of that metal, valued at $199,307, 7,029 ounces of silver, 198 pounds of copper, and 13,596 pounds of lead. The placers produced gold valued at $117,808, or nearly 58 per cent of the county total. There was, however, a decrease in placer gold amounting to $48,402 and an increase in gold from siliceous ore of $12,433. The ore output was greater by 7,485 tons than that of 1907 and amounted to 15,854 tons, from which $81,499 in gold and $3,050 in silver was won through the operation of 12 gold and silver mills. As many more mills were idle. The ore averaged $5.33 per ton in gold and silver. The county has 17 mining districts, but as 9 of these join each other and some have small production, they have been grouped to make what is commonly called Boise Basin, which includes the following districts: Centerville, Elkhorn, Gambrinus, Gold Hill, Granite, Idaho City, Moores Creek and Lower Moores Creek, Pioneerville, and Placerville.

Boise Basin region.—In 1908 this region produced from 8 deep mines 11,742 tons of ore, which yielded gold amounting in value to $158,242; 2,425 ounces of silver; 198 pounds of copper; and 2,106 pounds of lead. Of the gold, 28 placers produced $109,844. Most of the gold is deposited at Idaho City or at the United States assay office at Boise. The largest placer-gold producer of the district is

the Moline Mining Company, which has operated a floating dredge at Placerville for several years. The next 6 important producers are: Basin Branch placer, Boise Basin Hydraulic and Placer Company, Harwood Glenn Mining Company, Leary & Brogan placer, Oaks Mining Company, and Riley and Farren placers. According to the tenth annual report of the state mine inspector, some important dredge construction was under way by the Boston-Idaho Gold Dredging Company, which has moved a dredge of a daily capacity of 3,000 yards from Yreka, Cal., to its property below Idaho City, and will soon complete a 1,400-horsepower electric-power plant on the south fork of Payette River. This company was also having designed a larger dredge for the same ground, which comprises 600 acres and is said to contain about 16 cents in gold per cubic yard. The property is reported as having been thoroughly tested by drilling. There were 5 important deep-mine producers in 1908. The Golden Age Mining Company (Limited), at Placerville, operated its mine and 5-stamp mill for eight months and shipped bullion and concentrate. About 2,000 feet of work was done on this property. The Boulder Mining Company, near Idaho City, worked the Boulder and Molly McCarty mines, extended the tunnels to 500 to 600 feet, and produced bullion in the 20-stamp amalgamation and concentration mill. An aerial tram 3,300 feet long was constructed. The Golden Rod Mining Company was sinking a double-compartment shaft, which has reached a depth of 120 feet. Two Chilian mills on the property, with amalgamation and cyanide treatment, made short runs each month from July to November, and produced considerable bullion. The Belshazzar Mining Company, west of Quartzburg, operated a 10-stamp mill and produced bullion in 1908. The mine is opened by 1,000 feet of tunnels. The Last Chance and Golden Star mines, between the Iowa and Gold Hill, were operated by the Columbia Mining Company. The company has a 5-stamp mill now on the ground. The White Quartz Mining Company developed the Elkmeat claim near Idaho City by a tunnel 200 feet long. The Confederate mine at Quartzburg, belonging to the Gold Hill and Iowa Mines Company, was leased and produced bullion in the Huntington mill of the Amingo Company. At the Gold Hill and Iowa mines, which have been idle for years, development work was resumed. A new hoist was installed at the Pioneer shaft. The mines are opened by 2 shafts, 400 feet each, 5,000 feet of crosscuts, and 6,000 feet of drifts. Equipment consists of a 20-stamp amalgamation and concentration mill.

Deadwood Basin district.—The Merry Blue and Union claims produced bullion in an arrastre, and the Deadwood Placer Company shipped gold to the government assay office.

Highland Valley district.—The Highland Valley Power Company operated placers on Boise River, 18 miles southeast of Boise City, and secured considerable gold. The property consists of 400 acres above the Highland Dam. The gravel is said to run 30 cents per yard. As the capacity of the plant is 2,000 horsepower, there is more than sufficient power to operate the placers.

Payette River district.—The Jacobs Gulch placer, near Payette, produced in 1908.

Boise River district.—At Twin Springs, north of Boise River, $2,338 in gold was won from the Eureka, Boulder, and other claims in the vicinity.

Summit Flat district.—Northeast of Pioneerville the Black Jack mine produced bullion in a 12-ton Tremain steam stamp mill.

West View district.—This district suffered a decrease of nearly 50 per cent in value of product. The output of 1908 amounted to 4,020 tons of ore, from which $31,987 worth of gold, 4,487 ounces of silver, and 11,490 pounds of lead were obtained, a total value of $34,848. During 1908 neither the Pearl nor the Lincoln mine was operated for more than four months, and the Lincoln went into the hands of a receiver. The property is developed by a shaft 450 feet deep and by over 6,000 feet of drifts and shafts. Equipment consists of a 100-ton concentration and amalgamation mill, which saves about 75 per cent of the metallic contents of the ore reported to average nearly $10 per ton. More than 60 per cent of the gold saved was obtained through the smelting of the concentrate, which was shipped to Salt Lake. The expenses of mining and timbering in a talcose formation, difficulty in saving a large part of the metallic contents of the ore, and poor management are said to have handicapped the property in the past. The Iron Dollar Leasing Company operated the Lavan group, produced bullion and concentrate, and shipped crude ore. The property, consisting of the Iron Dollar, Judas, and Shamrock claims, is developed by a 200-foot shaft and by 1,000 feet of tunnels and drifts. The Easter 50-ton mill was operated. The Mint Gold and Silver Mining Company, whose property is developed by a tunnel over 1,000 feet long, treated ore in the Osborne mill and shipped concentrate. The Idaho Gold Mines Development Company, owning the Osborne mine and a 50-ton mill, shipped a small amount of bullion. The Granite State Mines Company did considerable work on the mine, which is opened by tunnel 1,854 feet long. There was no production from either the Hecla-Checkmate or the Whitman mines.

BONNER COUNTY.

The operation of the Ponderay smelter the last months of 1908 had a stimulating effect upon the mines around Lake Pend d'Oreille, and slight increases were recorded in all metals. The county was credited with a production of 197 tons of ore, yielding $161 in gold, 33,447 ounces of silver, 15,006 pounds of copper, and 5,077 pounds of lead, valued in all at $20,082. The entire product was from crude ore shipped to smelters, more than half of which was a siliceous ore containing nearly 300 ounces of silver per ton. The remainder was copper ore and a little lead ore.

Lakeview district.—Aside from the shipment of an insignificant quantity of lead ore, little was accomplished in the district in 1908. Preparations for development were made at the Conjecture mine of the Pittsburg Mining Company.

Pend d'Oreille district.—Seven mines in this district, which embraces the country north, east, and west of Lake Pend d'Oreille, supplied nearly all of the output of the county. The leading shipments were from the Blue Bird mine of the Blacktail Mountain Mining Company, B. F. and H. mine, Green Monarch Mining and Milling Company, the Minerva Mining and Milling Company, on Granite Creek, and the Katherine mine, at Blacktail. The Blue Bird has a shaft 100 feet deep and a tunnel 800 feet long, and produces a gray copper ore rich in silver. The B. R. and B. mine has a tunnel 1,840

feet long, but shipped no ore. The Grouse Mountain Mining Company did 700 feet of work on the Wonder Group. The Green Monarch Mining Company, at Hope, shipped copper ore. The tunnels aggregate 1,600 feet. The Midas Galena Mineral Company was reported as having done considerable development on Grouse Mountain. The geology of the district and the mines are described in a bulletin recently published by the Survey.[a]

Priest Lake district.—In the vicinity of Priest Lake there are many mines being developed, among which are the Camp Bird, Farmer Jones, and the mines of the Priest Lake Mining and Smelting Company.

CANYON COUNTY.

Only a small amount of placer gold was produced from along the Boise and Payette rivers. The Middleton Ore Reduction Company, at Middleton, has erected a 20-ton custom mill, designed to use crushing, amalgamation, cyanidation, and chlorination.

CASSIA COUNTY.

Only small test shipments of ore were made from the Cumora and Walton No. 2 in Stokes district in 1908. Production decreased from $2,191 in 1907 to $909 in 1908. The Melcher mine has a tunnel 2,175 feet long, which will have to be driven 500 feet to tap the vein at a depth of 1,200 feet. The Olympia, near Albion, is being steadily developed. The Southern Hercules Mining Company developed the Golden Eagle mine to a depth of 170 feet. It is stated that an 8-foot vein of lead carbonate ore has been disclosed, which assays high in lead, with silver and gold.

CUSTER COUNTY.

As a result of the idleness of the smelter of the Empire Copper Company, at Mackay, the total value of the county output decreased $465,886 in 1908. Twenty deep mines yielded 18,947 tons of ore, carrying 13,668.94 ounces of gold, 38,315 ounces of silver, 815,382 pounds of copper, and 226,332 pounds of lead, valued in all at $420,005. The decrease of more than 50 per cent in value was almost entirely due to a lessened copper production. Gold increased $106,693 as a result of shipments of bullion from the Golden Sunbeam mine and of matte from the Lost Packer plant. Of the total tonnage, over 78 per cent was siliceous ore, 20 per cent was copper ore, and the small remainder was lead ore. More than half the gold, however, came from copper ore, over one-third from siliceous ore, and less than 2 per cent from placers. Gold from placer mines, 7 of which were in operation, decreased chiefly as the result of the idleness of Womack's dredge, at Stanley; but gold in copper and siliceous ores made large advances. About half the silver was derived from copper ore, more than one-fourth from lead ore, and nearly one-sixth from siliceous ore. As the low-grade copper tonnage of the White Knob mine was almost entirely eliminated for 1908, the average total value per ton increased to $21.92, and the value of gold and silver per ton to $15.73. The

[a] Calkins, F. C., and McDonald, D. F. A geological reconnaissance in northern Idaho and northwestern Montana, with notes on economic geology: Bull. U. S. Geol. Survey No. 384, 1909.

greater part of the tonnage, or 14,866 tons, was treated in gold and silver mills, and produced 5,468.85 ounces of gold, 5,655 ounces of silver, and a few tons of concentrate. The remainder, 4,039 tons, was crude ore shipped to smelters, which produced $162,227 in gold, 31,073 ounces of silver, 814,962 pounds of copper, and 207,152 pounds of lead, with a total value of $294,971, at $73.03 per ton.

Alder Creek district.—Production was as follows: Ore, 453 tons; gold, $346; silver, 1,179 ounces; copper, 38,698 pounds; and lead, 29,387 pounds—all from 5 deep mines. The closing of the plant of the Empire Copper Company reduced the total value of the district output from $666,464 in 1907 to $7,313 in 1908. Aside from shipments of copper ore made by this company from the White Knob mine the only shipments of the district were those of lead ore from the Black Daisy, Champion, and Eureka mines. Development is reported to have opened ore on the Silver King group.

Bayhorse district.—Rich lead ore, containing about 58 ounces of silver, was shipped from the following properties: Forest Rose, Homestake, Dryden, Japan and Mary, Pacific, Good Friend, South Butte, and Cave. The production was: Ore, 192 tons; gold, $54; silver, 11,209 ounces; copper, 3,437 pounds; and lead, 194,740 pounds—with a total value of $14,628. Production was curtailed for lack of transportation.

East Fork district.—The Silver Bell Mining and Exploration Company developed property on the East Fork of Salmon River, east of Galena. A test shipment of silver-lead ore was made to Hailey. The district extends from Germania Creek south to the Blaine County line.

Loon Creek district.—In the extreme northwestern part of Custer County, the Lost Packer Mining Company, the only producer of the district, had the most successful year in its history. Production, which amounted to more than $100,000 in value in 1907, was more than doubled in 1908, although the 100-ton blast furnace was operated but seventy days. The expenses of operation are great, however, since coke, supplies, and matte have a wagon haul of 125 miles between Ivers and Mackay. The mine is developed to a depth of 800 feet by tunnels. The main ore body has not been thoroughly exploited beyond the 400-foot level, although adits Nos. 6 and 7 are in 700 feet. Little development was accomplished during the year, but a deposit of iron sulphide ore was opened south of the property, which assisted in reducing the siliceous Lost Packer ore. Matte, averaging per ton about 10 ounces of gold, 20 ounces of silver, and 50 per cent copper, was shipped to Baltimore for refining.

Sea Foam district.—At the end of the year, the Greyhound Mining and Milling Company was installing a mill to treat the rich pyritic ore. A small smelter is located on the property, but has not proved profitable.

Stanley Basin district.—Production in 1908 was valued at $4,138, nearly all in placer gold. This decrease from $10,296, the value of the output of 1907, resulted from the idleness of the dredge of the Saw Tooth Placer Mining Company. The largest placer product was that of the Joe's Gulch placer. The Valley Creek, the most important deep mine, was idle. The Stanley Dredging Company installed a new dredge, said to have a daily capacity of 3,000 cubic yards.

Yankee Fork district.—Production amounted to 14,862 tons of ore, carrying $116,236 in gold and 6,325 ounces of silver, valued

together at $119,588. This was an increase from $56,407 in gold and 3,111 ounces of silver produced in 1907. The Runover Gold Mining Company made a shipment of bullion and began development on property which had rich ore at the surface. The chief producer of the district was the Golden Sunbeam Mines Company, which made regular shipments of bullion and more than doubled its gold output. Nearly three-fourths of the gold is saved by amalgamation, only a small amount of concentrate being shipped each year. Tailings are saved for future treatment by the cyanide process. The present power plant is one of 75 horsepower. The ore shoot is reported to have increased in width as development progressed until it is 60 feet wide on the 400-foot level. This ore is reported to average $10 to $12 in value per ton, and a large deposit of low-grade ore is also said to exist.

ELMORE COUNTY.

Production for 1908 amounted to 24,261 tons of ore carrying 7,383.04 ounces of gold, valued at $152,621, and 7,135 ounces of silver, valued at $3,782—a total value of $156,403. This was an increase over the output of 1907 of 17,528 tons of ore, 2,981.20 ounces of gold, and $58,641 in total value. Silver decreased 3,120 ounces. Placer product amounted to $4,948, showing a slight increase. Except the output of surface mines, all the gold comes from siliceous ore, in which there was a great increase, largely the result of operations of the Bagdad-Chase Gold Mining Company. There were 11 placers and 12 deep mines operating, and the value per ton of the ore decreased from $13.89 to $6.24. Almost the entire ore product was treated at 5 gold and silver mills and resulted in bullion containing 6,103.32 ounces of gold, 5,504 ounces of silver, and in 153 tons of concentrates, valued at $21,932, or $143.35 per ton.

Bear Creek district.—A production valued at $1,146 was the result of the slight operation of 1 placer and 2 deep mines—the Bassler and the Blue Bird.

Black Warrior district.—The Fourth of July and the Blue Ribbon mines produced slightly. The Imperial Mining Company and the Overlook Mining Company are developing property in the locality.

Boise River district.—Placer gold was taken from the south side of Boise River near Twin Springs and in the Highland Valley district.

Middle Boise district.—The production amounted to 19,223 tons of ore carrying $95,794 in gold, and 5,086 ounces of silver, with a total value of $98,489, which was double the value of the output of 1907. Four deep mines and 3 placers contributed. A large output was expected from the Atlanta Mines (Limited), which tested its 150-ton mill without securing satisfactory results. Changes will have to be made before the ore can be treated. The Minerva made large shipments of bullion to Boise through the operation, in October, November, and December, of its 10-stamp mill driven by water power. Important work and production were accomplished at the Pettit mines, which were bought by the Bagdad-Chase Gold Mining Company. The property, which is developed by 1,500 feet of tunnels, produced bullion, and a concentrate treated by roaster and cyanide plant. A 20-stamp mill, using amalgamation, was originally on the property. A new mill of like capacity was added in 1908, as well as a 150-ton cyanide plant. The new equipment includes 16 Frue vanners, 8 slime tables, a Callow screen, and dewaterers, Dimmick

sizers, a 16-foot tube mill, and a Pierce amalgamator with 12-foot copper plates. Ore is conveyed from the mine to the mill over a 3,500-foot aerial tramway.

Neal district.—The only producer of the locality was the Homestake and Mountaineer Mining and Milling Company, which operated the mill the last seven months of the year and shipped bullion to Boise and concentrate to Salt Lake. Development consists of a tunnel 2,700 feet long and a shaft 327 feet deep. The mine was operated the entire year, and about 2,000 feet of work was done. Equipment includes a 10-stamp mill and a 30-ton cyanide plant added during 1908.

Pine Grove district.—The C. H. Gold Mines Company produced bullion, but less than in past years. Fire destroyed the 10-stamp mill and cyanide plant in May.

Snake River district.—Gold 0.940 fine was secured from the Midnight placer on Snake River near Glenns Ferry.

Twin Springs district.—On the south side of Boise River gold 0.778 fine was won from the Call and Pfoser placer.

FREMONT COUNTY.

The production in 1908 was valued at $2,833, which resulted from the shipment of 86 tons of ore. The total value in 1907 was $45,678, when much copper ore was marketed.

Little Lost River district.—Thirty miles south of the Weimer property, on the southwest slope of the Little Lost River Range, lessees operated the Great Western mine and shipped a rich lead ore.

Skull Canyon district.—The property of the Weimer Copper Company on Birch Creek, near Kaufman, was practically idle during the year.

Unorganized district.—The Scott mine, 4 miles from Birch Creek, was operated by the Birch Creek Mining Company, and shipped a car of silver-lead ore to Salt Lake.

IDAHO COUNTY.

Mine production of gold, silver, and associated metals in Idaho County, Idaho, in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
DEEP MINES.						
Gold.....fine ounces..	3,393.36	$70,147	7,268.54	$150,254	+3,875.18	+$80.107
Silver.....do....	1,786	1,179	9,568	5,071	+ 7,782	+ 3,892
Copper.....pounds..	3,043	609	233	31	− 2,810	− 578
PLACERS.						
Gold.....fine ounces..	1,964.02	40,600	2,064.64	42,680	+ 100.62	+ 2,080
Silver.....do....	394	260	339	180	− 55	− 80
	.....	112,795	.....	198,216	.....	+ 85,421

Idaho County, which had 15 producing districts, produced 9,333.18 ounces of gold, valued at $192,934; 9,907 ounces of silver, valued at $5,251; and 233 pounds of copper, valued at $31—a total value of $198,216. This increased production of $82,187 in gold and 7,727 ounces of silver was largely due to success at Elk City. There was

a slight increase in placer gold, the total output of which amounted to $42,680. There were 51 placer operators producing more than in any other county in the State. The rest of the gold, or nearly 80 per cent, was obtained from siliceous ore. Of the silver, 9,568 ounces came from siliceous ore and 339 ounces from placers. The ore from 17 deep mines amounted to 15,778 tons, showing an increase of 2,351 tons, and had an average value of $9.85. With the exception of 5 tons, all the ore was treated at 9 gold and silver mills, of which the county had 22 others idle during the year. Bullion shipped contained 5,505.61 ounces of gold and 1,653 ounces of silver.

Big Creek district.—Bullion was shipped from the Moscow mine, which has a 1-stamp mill. Tests were made on ore by the Columbia Mining Company, Pueblo Mining Company, and the owner of the Buckhorn mine.

Camp Howard district.—Placer gold in small amounts was produced in this district, as well as in the Clearwater, Dixie, Florence, Robbins, and Thunder Mountain districts.

Crooks Corral district.—The Crooks Corral placer produced gold, 0.954 fine, by the hydraulic method.

Dixie district.—Work was performed, but no production was reported, on the Majestic, Dixie-Royal, Diamond Consolidated, and Monadnock mines.

Elk City district.—Production from 9 placers and 5 deep mines amounted to 10,456 tons of ore, carrying $142,445 in gold and 7,561 ounces of silver, an increase in total value of $129,517. The placer output was $6,423, supplied mainly by the Gold Hill, Golden Rule, and Grangeville placers. The principal deep mines are the Buster, South Fork, Thunder Mountain, American Eagle, and Hope, all of which have mills. Little was done on any of these properties, except the Buster. Litigation hampered the South Fork. Much interest was evinced in the work of the Idaho Buster Mining Company (Limited), which acquired the Buster mine and continued the sinking of the shaft to the 400-foot level, which is connected with a 700-foot tunnel. A 10-foot fissure vein is reported, with ore averaging about $10 or $15 per ton. Equipment includes a 10-stamp mill, 6 concentrators, and a 40-ton cyanide plant. Most of the product was bullion, shipped to Boise; the rest was concentrate and precipitate, which was sent to Tacoma. The success which this mine has achieved at depth will be a strong incentive to substantial work on neighboring properties.

Marshall Lake district.—Promising development continued on the Goodenough and Mount Marshall properties, although no production was reported.

Newsome district.—Seven placers and 2 deep mines contributed $10,826 in gold and 90 ounces of silver. The 2 large placer operators were the Newsome and Leggett Creek Hydraulic Mining Company and the Moose Creek Gold Mining Company. Small shipments of bullion came from the Iron Crown and the Little Giant deep mines, and a mill was installed at the Meadow Creek property.

Orogrande district.—The district produced $9,615 in gold and silver. There was considerable activity in prospecting, and discoveries were made on Ten Mile and Four Mile creeks. The Butte and Orogrande Mining Company operated the low-grade deposit of the Hogan mine on Crooked River and a 10-stamp mill and cyanide plant. A similar deposit is being developed by the Twin Butte Mining Company,

which installed crushers, a 10-foot Chilian mill, concentrators, and cyanide plant. The Elk Trail placers produced bullion 0.826 fine. The Umatilla Company reported 2,200 feet of work and much ore developed.

Robbins district.—There was no production in 1908. Gold and silver valued at $16,199 was produced in 1907. The Cracker Jack, Jumbo, and Big Buffalo, large producers in the past, were idle in 1908.

Salmon River district.—From along Salmon River $4,627 in gold and 19 ounces of silver were won by placer operations.

Simpson district.—Near Lucile, 6 placers produced $2,395 in gold and 24 ounces of silver. The largest producers were the Cove, the Dandy, and the Rattler.

Thunder Mountain district.—Aside from a little surface work, nothing was done in 1908. The Dewey and the Sunnyside mines were idle. The former was a large producer in 1907 and previous years.

Warren district.—The production amounted to 58 tons of ore, carrying $16,453 in gold, 2,038 ounces of silver, and a little copper, valued in all at $17,564. The principal placers are the Golden Rule, the Gott, and the Shissler Creek; the operators of the White Mountain shipped bullion from quartz operations. The Little Elfrieda mine was developed.

KOOTENAI AND LATAH COUNTIES.

These counties produced only placer gold in 1908, valued at $4,225, with 23 ounces of silver. The Tyson Consolidated Gold Mining and Milling Company operated placers at Tyson three months. The remainder of the gold came from the Gold Creek and Hoodoo districts in Latah County. The Inland Empire Copper Company, at Troy, a station on the Northern Pacific Railroad, did 225 feet of work.

In the Hoodoo or Blackbird district, in the extreme northern part of the county, there was considerable activity. The Mizpah Copper Company has a tunnel 1,200 feet long. The Mountain Gulch Mining and Milling Company, also at Harvard, has developed free milling ore by a shaft 120 feet deep and 3 tunnels. During the fall a hoist, Blake crusher, 4-foot Huntington mill, and plates were installed.

LEMHI COUNTY.

Mine production of gold, silver, and associated metals in Lemhi County, Idaho, in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
DEEP MINES.						
Gold.....fine ounces..	2,502.83	$51,738	1,785.13	$36,902	− 717.70	−$14,836
Silver.....do....	50,444	33,293	22,825	12,098	− 27,619	− 21,195
Copper.....pounds..	52,461	10,492	10,366	1,368	− 42,095	− 9,124
Lead.....do....	1,932,356	102,415	700,622	29,426	−1,231,734	− 72,989
PLACERS.						
Gold.....fine ounces..	1,570.93	32,474	1,730.88	35,780	+ 159.93	+ 3,306
Silver.....do....	128	84	167	88	+ 39	+ 4
	.....	230,496	.....	115,662	.....	−114,834

Source of gold and silver in Lemhi County, Idaho, in 1907 and 1908, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Siliceous ore.	Lead.	Copper ore.	Copper lead ore.	Total.
Gold	1907	1,570.93	2,289.92	73.07	139.85	.....	4,073.77
	1908	1,730.88	1,775.06	9.00	.65	0.42	3,516.01
Silver	1907	128	4,878	45,120	446	.....	50,572
	1908	167	1,055	21,264	30	476	22,992

Lemhi County in 1908 produced 3,515.99 ounces of gold, valued at $72,682; 22,992 ounces of silver, valued at $12,186; 10,366 pounds of copper, valued at $1,368; and 700,622 pounds of lead, valued at $29,426—a total value of $115,662. There were decreases in all metals, as shown by the table, and they amounted to $114,834 in total value. Gold was derived almost entirely from placers and siliceous ore, each source being credited with about 50 per cent. Most of the silver came from lead ore, of which little was shipped in 1908. Of the 37 mines from which production was reported, 18 were placers. The deep mines supplied 2,515 tons of ore, of which 1,812 tons were treated at gold and silver mills, and 703 tons were shipped direct to smelters. The smelting ore was valued at $63.65 per ton and the gold ore at $19.07 per ton. There were 6 gold and silver mills in operation, 13 were idle, and 2 were constructed during the year. The output was from 17 mining districts, all of which suffer from lack of transportation.

Eureka district.—Two deep mines and 5 placers produced $15,741 in gold and 58 ounces of silver. This gold came almost entirely from the Mullan dredge on Moose Creek. The U. P. and Burlington Gold Mining and Milling Company shipped only a small amount of bullion. The Comstock Mining and Milling Company developed the Grey Eagle and Lost Mine groups, and made trial runs in the Tin Doy mill. The Golden Reef Mining Company was preparing for production. The Copper Queen Mining and Smelting Company did development work on the Queen and Crescent mine 5 miles east of Salmon. About 2,000 feet of work has been done in tunnels and crosscuts, gaining a 400-foot depth on the Queen vein. Fifteen stamps are now on the ground.

Eldorado district.—The Bohannon Bar placers, near Baker, formerly reported in the Gibbonsville district, made one of the largest placer productions of the county.

Forney district.—Development and slight production were reported from the Rabbit Foot and Oregon-Idaho mines, upon which much work has been done in tunnels and crosscuts.

Gibbonsville district.—Crosscutting and drifting to the extent of 1,400 feet were done by the American D. M. and R. Company, but no ore was treated in the 20-stamp mill. A cyanide plant was completed in December. Gold was taken from the Belcher and Allan Brothers placers.

Indian district.—The most important production of the county was that from the Kittie Burton and Ulysses mines at Ulysses. The lessees are running a 500-foot tunnel and 380 feet of drifting were accomplished. Tests with cyanide were unsuccessful, but concentrators will be added.

Junction district.—The Junction Mines Company did much work in drifting and upraises, and shipped a rich lead-silver ore to Carnegie, Pa.

Kirtley Creek district.—The Tin Doy mine was idle, and only a little placer work was done in the district.

Leesburg district.—Four placers produced $4,935 in gold. The Richardson placer was the largest producer.

Mackinaw district.—Only a slight placer production was secured from this locality in 1908. The Leesburg Mining Company is further developing the Italian group, an important bullion producer in the past.

Mineral Hill district.—A test run in the Kentuck mill was made on ore from the Speculation group, 1 mile south of Shoup.

Pratt Creek district.—The Climax mine was idle, but some old concentrate, containing gold, silver, and lead, was shipped.

Spring Mountain district.—Production from 4 mines amounted to 128 tons of ore, carrying $48 in gold, 3,349 ounces of silver, 2,906 pounds of copper, and 124,255 pounds of lead. The shippers were the Lemhi-Union, Iron Mask and Galena, Teddy and Elizabeth, and High Ore. Production of this district and the Texas district will be greatly improved by promised railroad facility and the lead smelter at Hahn.

Texas district.—In 1907 this district produced silver-lead ore valued at $112,287, but the value in 1908 was only $9,058, as the Pittsburg-Idaho Mining Company was practically idle during the entire year. The 80-mile haul was too costly when the price of lead decreased. The operators of the Latest Out mine, which has a 300-foot tunnel, made a shipment of lead ore. Development amounting to 1,200 feet was done on the Andy Consolidated group of the Allie Mining Company, Limited, on Horse Shoe Gulch.

Yellow Jacket district.—The Black Eagle Gold Mining Company, owning claims on Arrastra Creek, erected a 5-stamp mill in 1908 and did considerable tunneling.

Unorganized district.—Thirty miles southeast of Salmon City, near the divide, the Copper Queen Mining and Smelting Company shipped some bullion and copper concentrates, the result of work in 1907. The company put all efforts on the Queen mine in Eureka district.

Parker Mountain district.—A 10-ton Chilian mill was installed at the property of the Parker Mining Company. Production, however, was slight. A small quantity of ore, rich in gold and silver, was produced from the Ed. Williams mine.

LINCOLN COUNTY.

Placer gold from Snake River, near Hagerman, and from the Blue Lakes districts, valued at $939, was taken from the Good Luck, Boulder Hill, and Salmon Falls placers.

NEZ PERCE COUNTY.

The entire production of the county was that of placer gold in Burnt Creek, Pierce, and unorganized districts, amounting to 2,185.53 ounces of gold, valued at $45,179, and 530 ounces of silver, valued at $281, a total value of $45,460 from 18 placers. The output for 1907 was $54,848.

Burnt Creek district.—At Dent $3,827 in gold and 45 ounces of silver were taken out by hydraulic mining and sluicing. The largest producer was the Boise placer, others being Cranberry Creek, Daylight, and Grubstake.

Pierce district.—Placer production, largely from the property of the Idaho Company (Limited), amounted to $41,255 in gold and 484 ounces of silver from 11 operators. The dredge was in operation eight months, and another, formerly operated at Delta, will be installed at Pierce. The holdings of the company were prospected by drills, the depth to bed rock being from 12 to 15 feet. Other important producers were the Rich Hill Water and Mining Company, American Placer Mining Company, Rhodes Creek Mining Company, and Bunker Hill placers. The Orogrande Placer Mining Company was organized to operate on Orogrande Creek by Ruble elevator. Although there was no production from deep mines, a 5-stamp mill was installed at the Bond mine, and the Ozark was driving a 1,200-foot tunnel to cut the ledge at 500 feet.

ONEIDA COUNTY.

Snake River district.—At Neeley, placer gold, aggregating $4,412 in value, was taken from the Daylight, Lookout, and Bonanza Bar, and Rosecranz ground.

OWYHEE COUNTY.

This county produced 51,491 tons of ore, carrying 18,862.14 ounces of gold, valued at $389,915; 857,537 ounces of silver, valued at $454,495; and 288 pounds of lead, valued at $12—a total value of $844,422. There were 4,471 more tons treated in 1908 than in 1907, and there was an increase of 1,644.56 ounces of gold, but although the silver increased in quantity 63,595 ounces, it decreased in value $69,507 on account of the difference in price. This, with slight decreases in copper and lead, made the total value $36,246 less than that of the production of 1907. Seven placer mines and 7 deep mines supplied the production, but almost all was from siliceous ore, as the placer yield was only $1,133. Five gold and silver mills, 1 of which was new, were in operation during the year; 1 was being constructed and 5 others were idle. The value per ton in gold and silver was $16.38, against $18.68 in 1907. The entire output, except for placers on Snake River and a little lead ore, came from Carson district. As in the past, the 2 important producers were the De Lamar Company (Limited) and the Trade Dollar Consolidated Mining Company. The Banner, Sunnyside, Jap, and Village Blacksmith produced bullion. The district produced $389,043 in gold and 857,407 ounces of silver. In gold and silver mills, 51,483 tons of ore yielded 16,111.66 ounces of gold and 363,467 ounces of silver in bullion, as well as 170 tons of concentrates, valued at $314,137, or $1,847.86 per ton of concentrate. The value per ton of the ore treated was divided as follows: $6.46 in gold and $3.74 in silver in bullion, and $6.10 in gold and silver in concentrates, a total of $16.30 per ton. The De Lamar Company (Limited) increased its production by nearly 3,000 ounces of gold and made a larger output than during any other of the last four years. The plant is equipped with a 150-ton Chilian mill, which prepares the ore for agitation in cyanide solution. Three-fourths of the value

of the ore is in gold, the remainder being in silver. The Trade Dollar Consolidated Mining Company, at Dewey, operated eleven months during the year and shipped a large amount of bullion and concentrate through the operation of the 20-stamp mill. The property is opened by tunnels, the longest of which is 7,000 feet. In 1908, work consisted of 5,041 feet of drifts, 1,140 feet of crosscuts, and 129 feet in raises. At the end of the year the Banner Mining and Milling Company made its initial shipment of bullion, built a 30-ton mill, equipped with 4 Nissen stamps, amalgamation, and concentration. The main adit is 250 feet above and 1,500 feet distant from the mill, and the ore is delivered by tram. Another tunnel is now being driven from the mill level. Considerable work was done in development and construction at the Potosi mine. Rich ore was reported in drifting 170 feet east and west on the 300-foot level. The new mill, which made a short run in December, was built for 10 stamps, but only 5 were installed. These, with Wilfley concentrators, a tube mill, amalgamating pans, and settlers complete the equipment. Development was progressing at the Metallic, Village Blacksmith, Silver City, Wennersten, Federal, and Rooster Comb mines. A shipment of bullion was made from the Sunnyside.

Snake River district.—Gold valued at $870 was taken from Snake River near Oreana, Wilson, Garnet, and Glenns Ferry.

SHOSHONE COUNTY.

Mine production of gold, silver, and associated metals in Shoshone County, Idaho, in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
DEEP MINES.						
Gold.....fine ounces..	3,118.49	$64,465	3,293.61	$68,085	+ 175.12	+ $3,620
Silver.....do....	7,266,725	4,796,039	6,364,454	3,373,160	− 902,271	−1,422,879
Copper.....pounds..	7,199,648	1,439,929	9,042,876	1,193,660	+ 1,843,228	− 246,269
Lead.....do....	229,442,987	12,160,478	204,138,418	8,573,814	−25,304,569	−3,586,664
Zinc.....do....	6,948,655	409,971	.....	.....	− 6,948,655	− 409,971
PLACERS.						
Gold.....fine ounces..	833.55	17,231	584.47	12,082	− 249.08	− 5,149
Silver.....do....	137	90	98	52	− 39	− 38
	.....	18,888,203	.....	13,220,853	.....	−5,667,350

Source of gold and silver in Shoshone County, Idaho, in 1907 and 1908, by kinds of ore, in fine ounces.

Metal.	Year.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Lead-zinc ore.	Total.
Gold	1907	833.55	87.43	383.18	2,575.27	72.60	3,952.03
	1908	584.47	650.69	300.18	2,342.74	.....	3,878.08
Silver	1907	137	135	454,107	6,597,493	214,990	7,266,862.00
	1908	98	374	607,553	5,756,527	.....	6,364,552

Within a space of 20 square miles in the vicinity of Wallace, metals were produced valued at nearly 86 per cent of the total value of the State's output for 1908. More than 98 per cent of the lead, 90 per cent of the copper, 85 per cent of the silver, and 5.5 per cent of the gold produced in Idaho were derived from that small portion of Shoshone County. The output of the county in 1908 was far below normal, since the total value of all metals decreased by the large amount of $5,667,350. The output of copper produced was considerably more than in 1907, but the total value was far less on account of the low price in 1908. Most of the gold and silver has its source in the lead ore, although some is derived from copper ore, placers, and siliceous ore. In 1907 lead-zinc ore was an important product, but none was treated or shipped in 1908. There were 43 mines, including 15 placers, producing in 1908, but most of the output was derived from 8 large mines. The total crude ore was 1,551,680 tons, or 91 per cent of the ore mined in the State. The tonnage includes 213,180 tons of old tailings made into concentrates; 1,023 tons of ore treated in gold and silver mills, containing 385.54 ounces of gold and 56 ounces of silver; 1,197,201 tons of concentrating ore, which, with the tailings, made 181,200 tons of concentrates; and 140,276 tons of crude ore shipped to the smelter. The concentrates contained 2,368.92 ounces of gold, 4,449,306 ounces of silver, 65,237 pounds of copper, and 170,892,167 pounds of lead, with a total value of $9,593,184, at $52.95 per ton. The crude ore shipped direct to smelters contained 539.15 ounces of gold, 1,915,092 ounces of silver, 3,977,639 pounds of copper, and 33,246,251 pounds of lead, and was valued at $3,607,535, or $25.71 per ton. Of the crude ore, 103,137 tons were copper ore, averaging 4.35 per cent of copper. An average assay of the concentrates would show 0.013 of an ounce of gold, 24.55 ounces of silver, and 47.15 per cent of lead. The crude shipping ore, excluding the copper ore, assayed, silver, 32.5 ounces, and lead, 44.76 per cent. Placer gold, valued at $12,082, was won from Beaver and Prichard creeks.

Beaver district.—This district comprises about 10 square miles in the vicinity of Beaver Creek, north of Wallace. The output from 2 deep mines and 8 placers amounted to 262 tons of ore, carrying $7,154 in gold, 8,748 ounces of silver, and 329,519 pounds of lead, and was valued at $25,630. The producing placers, which supplied $7,100 in gold and 68 ounces of silver, were as follows: Black Hill, American Gulch, Gilbert, Fehling, New Year, and Wedge. The most important was the Black Hill on Trail Creek at the mouth of Potosi Creek. There is said to be good placer ground in Beaver Creek, but as it is 40 feet to bed rock, it is difficult to mine it with profit. The dredge near Delta was removed to Pierce. The Callahan group and the Idora produced lead ore, but the latter only in small quantity, as the mine was idle most of the year. The Nipsic property is said to have considerable work done and ore in sight.

Coeur d'Alene district.—This district lies north of the Beaver district along Prichard and Eagle creeks, west and north of Murray. Some bullion was shipped from the Burton mine and gold from the Daisy placer.

Eagle district.—The production amounted to $4,474 in gold, from 4 placers, the principal one of which was the Eagle placer.

Evolution district.—This district lies east of Big Creek and Moon Creek and west of Lake Creek and Revenue Gulch, in the vicinity of Osburn. The production amounted to 817 tons of ore, carrying $136 in gold, 12,511 ounces of silver, 1,413 pounds of copper, and 132,713 pounds of lead, and was valued at $12,528. The Charles Dickens was the largest shipper. In January the 100-ton concentrator was destroyed by fire. A plant of 150 tons took its place and was operated for a short time, but at the end of the year the property was sold for debts. The Evolution mine was operated by the Evolution Holdings Company, and a small test shipment was made during development work. The shaft has a depth of 300 feet and the tunnel is 500 feet long. A shipment of copper ore was made by the Gray Copper Mines Company, and one of lead ore was made from the Yankee group. Development was carried on at the Mineral Point, Tam O'Shanter, Rainbow, H. E. M., and other mines.

Hunter district.—From a point 2 miles east of Wallace, this district extends along Coeur d'Alene River to the Montana line, south to the St. Joe Mountains, and north to the Divide. The production was 330,704 tons of ore, carrying gold valued at $12,295; silver, 1,089,250 ounces; copper, 8,974,803 pounds; and lead, 22,483,242 pounds; and was valued at $2,718,567, a decrease from $3,837,898 in 1907. The district, which ranks third in the State in the value of production derived its output from only 3 mines, the Morning, the Snowstorm and the Gold Hunter. The Morning mine, of the Federal Mining and Smelting Company, was idle the first half of the year, but the 1,000-ton concentrator was operated and about 400 men were employed the last six months. The company has abandoned the old surface railroad to No. 5 tunnel, and the output was hauled by electricity through No. 6, which is 2 miles long. Each year the producers of the county make reports to the county assessor, who formerly published the pounds of lead and the ounces of silver produced by each important shipper. For 1908, however, there were but four items published, the tonnage of shipments, including crude ore and concentrates, the total value of the ore, expenses, and net profits. The Morning mine, according to these figures, shipped 189,975 tons, mostly concentrate, having a total value of $843,305. Net profits were only $16,855. The Gold Hunter Mining and Smelting Company operated the 300-ton concentrator for nine months and did considerable development work, of which there is 4,500 feet on the property. The Snowstorm Mining Company was idle only forty-nine days in the first part of the year, after which ore was shipped to various smelters at an increased rate, thereby surpassing the production of 1907. Of this ore, 103,062 tons, averaging about 6 ounces of silver, 4.5 per cent of copper, and 90 per cent of silica, were shipped to the Anaconda, Boston and Montana, Granby, Tacoma, Trail, and Pittsburg and Montana smelters. The leaching plant was idle in 1908. The mine is opened by 4 tunnels. Nos. 1 and 2 tunnels are not used, as the ore in them is the carbonate, formerly used in the leaching plant. No. 3 has been the working tunnel. No. 4 was driven 1,491 feet in 1908 and will tap the vein at a depth of 1,700 feet, or 550 feet below the present workings. According to figures of the county assessor the value of the output was $1,096,185, and the net profit was $162,148. Three dividends were declared, totaling $150,000. Development is apparently making a large mine out of the Star mine, which lies west

of the Morning property. It is said that the ore shoot is 500 feet long and from 4 to 12 feet wide on the 700-foot level. Another tunnel will be driven to open the ore at greater depth. Many companies in the district are doing extensive development on the Alice, Midnight, Butte, Coeur d'Alene, and other mines. The Monitor mine, east of Mullan, near the Montana line, was bonded to the Success Mining Company and was developed by it. The mine is a producer of rich copper ore and has the advantage of being close to the new line of the Chicago, Milwaukee and St. Paul Railroad.

Lelande district.—The value of the output of this district, which extends along Canyon Creek, was greater than that of any other in the State, largely due to the percentage of silver in the ore, as Yreka district surpassed it in the output of lead. There were produced 496,151 tons of crude ore, containing gold valued at $30,148; 3,430,452 ounces of silver; 60,489 pounds of copper; and 83,069,712 pounds of lead; valued in all at $5,345,201. In 1907 the district produced metals, including zinc, to the value of $8,068,072. According to the figures given the assessor, the Hercules Mining Company, which operated its 300-ton concentrator the entire year, shipped 19,445 tons of crude ore and concentrate valued at $1,195,872. Net profits were $383,751, out of which $312,000 in dividends were paid. In 1908 the mine is said to have greatly increased its value by the showing in No. 4 tunnel, which reached the ore shoot 5,000 feet from the portal and 700 feet below the lowest workings. This ore shoot is said to be about 70 feet wide 2,000 feet below the surface. Operations at the Tiger-Poorman mine of the Federal Mining and Smelting Company were carried on at a loss to the company, and in October the underground machinery was removed and taken to the Standard-Mammoth mine at Mace. On account of the low prices of metals, the Hecla mine was not operated the first five months of the year; nevertheless it shipped ore and concentrate to the value of $569,805, of which $108,798 was net profit. Dividends amounting to $190,000 were paid during the year. The new electric hoist will raise 3,000 pounds of ore. The shaft has a depth of 900 feet, and the concentrator, equipped with a sorting plant, has a capacity of 300 tons. At the Standard-Mammoth mine at Mace, the Federal Mining and Smelting Company has sunk the shaft to the 1,450-foot level. The 1,000-ton concentrator was operated continuously, and, according to county figures, 285,400 tons of ore were marketed. This doubtless is crude shipping ore and concentrating ore. The total value was $2,583,961, of which the net profit was $693,124. The Federal Company disbursed $840,000 on its preferred stock in 1908. The mines of the Frisco Mining Company, at Gem, were worked on a small scale by lessees. In the early part of the year, the Rex Mining Company operated its 150-ton concentrator and shipped considerable lead concentrate. The Stanley Consolidated Mining and Milling Company made tests on its ore in the mill of the New Jersey Company, at Kellogg, through which bullion was sent to the government assay office, and concentrate, rich in gold, was shipped to Tacoma. No antimony ore was disposed of during the year. The Marsh group, at Burke, made its initial shipment of lead ore. Other mines in the vicinity are the Ambergris, Black Bear Fraction, Great Western, Imperial, Headlight, Moonlight, and Tamarack and Chesapeake.

Placer Center district.—This district extends along Nine Mile Creek north, and Placer Creek south of Wallace. In 1908 the output was unusually small, amounting in value to only $2,649. In 1907, on the other hand, the value was $559,195, including that of 3,124,732 pounds of lead, 4,704,000 pounds of zinc, 174,812 ounces of silver, and $689 in gold. Both the Pittsburg Lead Mining Company and the Success mine failed to produce in 1908. Near the Pittsburg property, the operators of the Ruth have 2,000 feet of tunnels and drifts, and are said to have struck ore at a depth of 400 feet. The operators of the Castle Rock, south of Wallace on Placer Creek, shipped some fluxing ore, containing a little copper and gold, to the smelter. The Hornsilver, on the same creek, reported 1,200 feet of work and ore in sight

Summit district.—From Murray east to the Montana line the district extends along Prichard Creek, and about 4 miles from north to south. The value of the output amounted to $26,091 in 1907, when the operators of the Bear Top shipped lead ore; but in 1908 production was a small amount of rich gold ore from the Pilot. Considerable work was done, however, on lead-silver veins. The Black Horse, Chicago-London, Paragon, Monarch, Bear Top, Granite, and Allie, and Gold Back are some of the mines which are expected to be developed by the advent of the railroad.

Yreka district.—This region, near Wardner, lies west of Moon Creek and Big Creek, and contains the largest lead mine in the State. Six deep mines in this locality in 1908 produced 723,476 tons of ore, which contained $23,626 in gold, 1,822,008 ounces of silver, 4,890 pounds of copper, and 98,082,577 pounds of lead, valued in all at $5,109,403. This is an increase in lead, but the value of the output of 1907 was more than $1,000,000 greater. The Bunker Hill and Sullivan M. and C. Company operated its 1,000-ton concentrator at Wardner the entire year, and produced but little less than the output of 1907. According to the county figures, 358,190 tons of ore were mined, valued at $3,321,025, from which a net profit of $901,721 was obtained. The company paid $855,000 in dividends in 1908. At the end of 1908 construction was well under way on a 500-ton unit of a new concentrator. When this is completed, another of the same size will be added, according to present plans, and the old mill will be remodeled, thus doubling the milling capacity of this great producer. The Last Chance mine, of the Federal Mining and Smelting Company, operated nearly all the year and produced, according to county figures, 153,320 tons of ore, most of which was concentrated. This had a gross value of $1,221,758, of which $221,609 was net profit. At the Sweeny 500-ton mill a large tonnage of tailings was also treated by the Shoshone Concentrating Company. The operators of the Surprise mine made their initial shipment of lead concentrate. The operators of the Wisconsin mine, the Cœur d'Alene Consolidated Mining Company, made a shipment of copper ore. Important among those not yet shipping are the Caledonia, Hypotheek, Nabob, Corrigan, and Government Gulch mines.

TWIN FALLS COUNTY.

From Snake River, near Twin Falls, $2,220 in placer gold was taken out by sluicing. The Klondyke was the most productive claim.

WASHINGTON COUNTY.

Seven Devils district.—The production of this county, which was that of the Seven Devils district, was 259 tons of copper ore, containing $87 in gold, 1,285 ounces of silver, and 123,647 pounds of copper, with a total value of $17,089. The output of 1907 was valued at $31,796. The operators of the Peacock, Lockwood, and Arkansas mines were the shippers. The Arkansas mine is opened by a tunnel 600 feet long. Heretofore the haul of ore has been 46 miles to Council, so that many of the properties are doing active development work while construction is in progress on the railroad down Snake River. The Idaho Gold Coin Mining and Milling Company completed a drain tunnel 1,600 feet long and prospected the vein from this level. The property has produced considerable gold in the past.

MONTANA.

By V. C. Heikes.

PRODUCTION.

The production of gold, silver, copper, lead, and zinc in Montana for the year 1908 was valued at $42,036,710, according to the reports of 566 producers, including 157 placers. Copper showed a large increase, from 220,108,792 pounds in 1907 to 251,667,795 pounds in 1908, worth in 1908 at its average commercial value $33,220,149, which was 79 per cent of the total value of the metals. Silver was second in value, amounting to 10,356,199 fine ounces, valued at $5,488,785; and gold was third, with an output of 147,913.34 ounces, valued at $3,057,640. The greatest quantity of gold was produced from deep mines in Fergus County and placers in Madison County; Silverbow County led in the production of silver and copper. The greatest quantity of lead was from Jefferson County, followed closely by Lewis and Clark County. Zinc ore was reported from Silverbow County only, and in quantity was nearly seven times greater in 1908 than in 1907. The total production of crude ore smelted in 1908, 807,270 tons, nearly equaled in quantity that of concentrates smelted, 885,329 tons. The larger part of these totals, aggregating 92.5 per cent of the crude ore and 99.3 per cent of the concentrates, was produced in Silverbow County. Crude ore to smelters was principally produced from mines in Silverbow County, the output consisting for the greater part of copper ore, with some siliceous lead and silver ores. Jefferson County was next in importance with a siliceous lead-silver and copper ore. These two counties, in order named, were also the principal producers of concentrates, with copper and silver predominating in the product of the former county, and lead with silver in the product of the latter county. Gold and silver mills located in Fergus, Chouteau, and Lewis and Clark counties treated, in the order named, the largest tonnages of siliceous gold ore. The placer product was reported principally from Madison, Powell, and Missoula counties, in the order named. Eighty per cent of the total placer output was produced in Madison County.

The variations in the metallic production of Montana during 1907 and 1908 are shown in the table which follows.

Mine production of gold, silver, and associated metals in Montana in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	158,970.51	$3,286,212	147,913.33	$3,057,640	− 11,057.17	− $228,57
Silver.....do....	9,317,605	6,149,619	10,356,199	5,488,785	+ 1,038,594	− 660,83
Copper.....pounds..	220,108,792	44,021,758	251,667,795	33,220,149	+31,559,003	−10,801,60
Lead.....do....	3,748,304	198,660	4,596,570	193,056	+ 848,266	− 5,60
Zinc.....do....	243,100	14,343	1,640,000	77,080	+ 1,396,900	+ 62,73
	....	53,670,592	.....	42,036,710	.....	−11,633,88

Montana in 1908 had five of its smelting plants in operation—two copper plants at Butte, in Silverbow County; one copper plant at Anaconda, in Deerlodge County; one copper plant at Great Falls, in Cascade County; and one lead plant at East Helena, in Lewis and Clark County. All of the smelters, except the copper plant at Great Falls, do a custom business which provides them with almost sufficient ores needed to flux the product mined from their own properties. About 49 per cent of the crude ore smelted and 7 per cent of the concentrates were treated at custom plants in Montana, Idaho, and Utah. Of the crude ore treated at custom smelters, the siliceous silver and copper ores and the oxidized and sulphide iron ores comprised the larger part of the product, the remainder, aggregating nearly 45,000 tons of ore and concentrates, being treated at lead smelters.

At gold and silver mills, situated in thirteen counties of Montana, there were treated 304,114 tons of ore, which yielded $1,272,843 in gold and 93,607 ounces of silver. In Deerlodge, Granite, and Lewis and Clark counties concentrates were produced which contained copper and lead besides the gold and silver.

ORE PRODUCTION 1908.

The production of ore in Montana in 1908 was 4,266,022 short tons including 83,310 tons of old slag and flue dust. Some tailings were re-treated by the cyanide process, but in total were a small quantity. No account is taken of the large tonnage of tailings and slimes from concentration operations used as a binder for briquetting the concentrates produced at the milling plants. The metal content of the slime and tailings, if recovered at all, is included in the total metal output and probably helps to lower the percentage of loss in smelting. Compared with the production of 1907, the total production of ore mined and treated increased 117,526 short tons in quantity, but in value per ton decreased from $12.85 in 1907 to $9.72 in 1908, mainly due to the lower average value of the metals in 1908. Production of siliceous ores increased from 386,240 tons in 1907 to 390,442 tons in 1908, an increase of 4,202 tons. The greatest quantity of this kind of ore was produced in Fergus County. Copper ore increased from 3,719,600 tons in 1907 to 3,828,876 tons in 1908, an increase of 109,276 tons. Silverbow County had the greatest output of copper ore, Broadwater County following. The production of lead ore increased from 14,360 tons in 1907 to 18,274 tons in 1908, an increase of 3,913 tons. The average value per ton of gold and silver in siliceous ore in 1908 was

$6.85, as against $8.24 in 1907; in copper ore, $1.32, as against $1.43 in 1907; in lead ore, $11.34, as against $24.40 in 1907; and in copper-lead ore, $47.84, as against $9.81 in 1907.

Subdivision of tonnage of ore sold or treated in Montana in 1908, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Total.
Beaverhead	350	363	60	.....	181	954
Broadwater	6,485	7,268	975	.....	.....	14,728
Cascade	76	.....	935	.....	92	1,103
Chouteau and Flathead	59,811	.....	7	.....	.....	59,818
Deerlodge	7,084	.....	.....	.....	.....	7,084
Fergus	197,697	.....	.....	.....	.....	197,697
Granite	17,310	850	643	.....	.....	18,803
Jefferson	50,598	2,873	8,216	.....	.....	61,687
Lewis and Clark	26,208	15	6,490	.....	24	32,737
Madison	11,369	22	281	.....	.....	11,672
Meagher, Park, and Ravalli	364	78	78	.....	.....	520
Missoula and Sanders	300	13	.....	.....	.....	313
Powell	96	182	570	.....	.....	848
Silverbow	12,694	3,817,212	19	28,133	.....	3,858,058
	390,442	3,828,876	18,274	28,133	297	4,266,022

GOLD.

The gold output of Montana for 1908, as reported by the producers, aggregated 147,913.34 fine ounces, which, at the standard value per fine ounce, amounted to $3,057,640. Compared with the figures of 1907, this indicated a decrease of 11,057.17 ounces in quantity and of $228,572 in value. The gold was principally produced from deep mines located in Fergus, Silverbow, Chouteau, Lewis and Clark, and Broadwater counties, and from placers in Madison, Powell, Missoula, and Lewis and Clark counties. Decreases are to be noted in all the counties, except Fergus, Beaverhead, and Broadwater. The placer production decreased in all the counties mentioned, except Madison and Powell. About one-sixth of the gold produced in Montana was from placers. Gold and silver mills treated 304,114 tons of ore, which yielded 41.6 per cent of the total gold produced in Montana, or 61,573.79 ounces, averaging $4.18 in value per ton. Fergus County is credited with the greatest yield from gold and silver ores. From 3,069,128 tons of ore treated at concentration mills in four counties, 885,329 tons of concentrates were saved, containing 16.2 per cent of the total gold of Montana, or 23,984.58 ounces, an average value per ton of 56 cents. There were smelted 807,270 tons of crude ore, containing 35,474.21 ounces, or 23.9 per cent of the gold produced in Montana, and averaging 91 cents per ton. The gold yield from placer mining in 1908 amounted to $549,995, an increase of $201,328 over that reported in 1907. Three-fourths of the value was produced by dredging operations in Madison County, the remainder by sluicing operations, a little of which was performed in all the counties mentioned in this report. No important new placer discoveries were reported. Carbon County, though not a regular producer, is credited with a small output from experiments in which concentration tables were used to save the gold on Clark's Fork Creek. The largest placer gold producing districts in 1908, named in order of importance, were Alder Gulch, in Madison County, and Pioneer district, in Powell County; for deep mines equipped with gold and silver mills, the

largest producing districts were North Moccasin district, Fergus County, and Little Rockies district, in Chouteau County; for smelting ores, Summit Valley district, in Silverbow County, and Cedar Plains district, in Broadwater County.

Source of gold product in Montana, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	
Beaverhead	117.31	35.68	143.08	5.29	.....	27.11	328.47
Broadwater	196.84	5,595.35	1,074.41	381.04	.....	.....	7,247.64
Cascade	.....	57.09	.....	148.82	.....	20.89	226.78
Chouteau, Carbon, and Flathead	202.69	12,610.23	.....	6.61	.....	.....	12,819.53
Deerlodge	118.81	3,192.60	.....	.....	.....	.....	3,311.41
Fergus	.....	36,818.02	.....	.....	.....	.....	36,818.02
Granite	617.50	3,846.14	19.32	17.89	.....	.....	4,500.85
Jefferson	77.83	5,347.59	440.90	860.36	.....	.....	6,726.68
Lewis and Clark	923.14	7,172.55	2,321.01	156.16	.....	5.01	10,577.87
Madison	20,072.67	8,012.43	.36	338.82	.....	.....	28,424.28
Meagher, Park, and Ravalli	229.54	296.71	.84	.....	.....	.....	527.09
Missoula and Sanders	1,496.58	20.40	.25	.....	.....	.....	1,517.23
Powell	2,395.58	96.40	26.73	362.94	.....	.....	2,881.65
Silverbow	157.51	2,372.15	28,338.44	25.51	1,112.23	.....	32,005.84
	26,606.01	85,473.31	32,365.34	2,303.44	1,112.23	53.01	147,913.34

SILVER.

The yield of silver amounted to 10,356,199 fine ounces in quantity, valued at $5,488,785; the average value of silver per fine ounce in 1908 being 53 cents. Compared with the figures of 1907, this indicated an increase of 1,038,594 ounces in quantity and a decrease of $660,834 in value. The output of silver comes mainly from copper ores, from which source were derived 8,274,951 ounces, of which Silverbow County produced 98.7 per cent. This output was 1,111,863 ounces in excess of the production of 1907. Siliceous ores yielded 1,715,386 ounces, or 16.5 per cent of the total. Silver also increased in production in 1908 from copper-lead ore, but decreased from lead ore and zinc ore. The largest silver-producing districts in 1908 named in order of importance, were Summit Valley district, in Silverbow County; Elkhorn district, in Jefferson County; Flint Creek district, in Granite County; Cataract district, in Jefferson County; Vaughn district, in Lewis and Clark County; and Colorado district in Jefferson County—all having produced over 50,000 ounces. Concentration ores in Summit Valley, or Butte, district yielded 5,445,318 ounces of silver, or a little over half the total output of the State. The crude ore shipped to smelters amounted to 807,270 tons in quantity yielding 4,480,763 ounces of silver, averaging 5.55 ounces per ton. At concentration mills 885,329 tons of concentrates were made yielding 5,681,292 ounces of silver, or an average of 6.42 ounces per ton. Gold and silver mills treated 304,114 tons of ore, yielding 93,607 ounces, contained in bullion from amalgamation and cyanide operations, and averaging 0.308 ounce per ton. Silverbow was the leading county in the production of silver, followed by Jefferson County.

Source of silver product in Montana, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Siliceous ores.	Copper ores.	Lead ores.	Zinc ore.	Copper-lead ore.	
Beaverhead	9	13,165	4,129	4,178	.....	17,473	38,954
Broadwater	26	1,221	2,472	21,783	.....	.....	25,502
Cascade	.....	9,083	.....	78,470	.....	6,468	94,021
Carbon, Chouteau, and Flathead	11	22,666	.....	12	.....	.....	22,689
Deerlodge	13	3,821	.....	.....	.....	.....	3,834
Fergus	.....	10,773	.....	.....	.....	.....	10,773
Granite	177	384,121	36,116	29,654	.....	.....	450,068
Jefferson	15	936,011	52,368	58,763	.....	.....	1,047,157
Lewis and Clark	260	17,403	2,493	87,163	.....	802	108,121
Madison	3,238	28,033	29	3,777	.....	.....	35,077
Meagher, Park, and Ravalli	18	65	4	427	.....	.....	514
Missoula and Sanders	57	176	33	.....	.....	.....	266
Powell	251	1,934	1,561	14,748	.....	.....	18,494
Silverbow	25	286,914	8,175,746	2,183	35,861	.....	8,500,729
	4,100	1,715,386	8,274,951	301,158	35,861	24,743	10,356,199

COPPER.

In 1908 the output of copper amounted to 251,667,795 pounds, valued at $33,220,149, at the average price for the year of 13.2 cents per pound. As compared with figures of 1907, this showed an increase of 31,559,003 pounds, which is credited almost entirely to Silverbow County, Broadwater and Jefferson counties supplying the next largest quantities. Six counties reported decreases in copper, the largest being that of Missoula. The closing of the copper smelters during the early part of 1908 and disastrous floods effecting transportation of ores from the mines to the smelters did much toward lessening the total output of copper in 1908. Ninety-nine per cent of the production of copper, or 250,150,712 pounds, valued at $33,019,894, was produced from the mines at Butte in Silverbow County. The crude shipping ores treated at smelters in 1908, aggregating 807,270 tons (including lead ores), yielded 77,481,532 pounds of copper, or an average of 95.98 pounds per ton, equivalent to 4.79 per cent. Included in this crude ore to smelters were 83,310 tons of old slag and flue dust resmelted, from which 3,044,700 pounds were recovered, and also 4,475,596 pounds of copper recovered from mine waters and old tailings by the use of scrap iron as a precipitant. The total quantity of concentrates produced in Montana was 885,329 tons, of which 883,808 tons, or 99.8 per cent, contained 171,103,640 pounds of copper, an average of 193.59 pounds per ton, or 9.68 per cent of copper; the remainder of the concentrates was produced from 10,210 tons of ore treated at gold and silver mills, which yielded, in addition to the bullion, an average per ton, of gold, 0.08 ounce; silver, 2.24 ounces; and copper, 0.14 per cent. Lead in small quantities is associated with many of the copper ores and concentrates and is not recovered at copper smelters. Only 9,315 tons of concentrates, containing copper and an excess in lead, were treated at lead smelters, yielding 387,325 pounds of copper, an average per ton of 2.08 per cent. Copper contained in concentrates was produced from 3,069,070 tons of ore, which yielded an average per ton of gold, 0.007 ounce; of silver, 1.84 ounces; and of copper, 2.78 per cent. This ore was

mined in the following districts: Backer and Beaver, in Broadwater County; Cataract and Elkhorn, in Jefferson County; Alder Gulch, in Madison County; and Summit Valley, in Silverbow County.

LEAD.

The output of lead increased from 3,748,304 pounds, valued at $198,660, in 1907, to 4,596,570 pounds, valued at $193,056, in 1908. The average value for the metal during 1907 was 5.3 cents per pound and in 1908, 4.2 cents per pound. Increases were made in Silverbow, Jefferson, Lewis and Clark, Cascade, Broadwater, and Madison counties. The largest production was in Jefferson County, which yielded 1,747,463 pounds, Lewis and Clark following with 1,237,518 pounds.

Crude ore to smelters contained three-fourths of the total output, or 3,432,732 pounds. Concentrates containing lead, produced at concentrating mills, aggregated 9,315 tons and contained 1,053,544 pounds of lead, averaging 113.10 pounds of lead per ton of concentrates, or 5.65 per cent. The concentrates were produced in the following districts, named in order of importance in the output of lead: Summit Valley, in Silverbow County; Elkhorn and Cataract, in Jefferson County; Tidal Wave, in Madison County; Beaver, in Broadwater County; and Bald Butte, in Lewis and Clark County, the productions ranging downward from 545,111 pounds to 21,213 pounds of lead contained in concentrates. The lead saved in concentrates at gold and silver mills aggregated 48,368 pounds, extracted from 26,358 tons of ore, which averaged in gold, 0.056 ounce; in silver, 0.29 ounce; in lead, 0.09 per cent; and a trace of copper.

ZINC.

Zinc, reported according to its yield of spelter, aggregated 1,640,000 pounds in 1908, valued at $77,080, which was an increase of 1,396,900 pounds in quantity and of $62,737 in value over the production of 1907. In 1906 the output was 6,579,000 pounds. The average price of spelter for the year was 4.7 cents per pound. Experiments by dry concentration in the use of Sutton tables and dielectric separators proved successful with the ores mined near Butte, but it is said that an excessive amount of dust made by the plant was objected to by residents in the vicinity, and that the mill was closed. Experiments with other methods of zinc concentration are being carried on at the plant of the Butte Reduction Works on Elm Orlu and Butte and Superior zinc ores, of which both properties are reported to have a considerable tonnage in the upper levels, averaging 21 per cent of zinc, 12 ounces of silver, 1 per cent of copper, 0.04 ounce of gold, 3 per cent of iron, and 58 per cent of silica per ton.

MINING INDUSTRY IN MONTANA IN 1908.

Better metal prices in 1908 and lower costs of production led to a rapid recovery from the effect of the financial panic of 1907 in placing the industry, to a certain extent, on its old footing. This is gaged largely by the annual output of copper, 96 per cent of which is produced from the mines by ten large mining organizations at Butte.

The smelters, which were closed in the latter part of 1907, did not resume until March in 1908. One of these, the Washoe smelter at Anaconda, was closed during this time, and in June the smelter at Great Falls was badly damaged by floods in the Missouri River, which caused the cessation of operations for three months. Both of these plants are the property of the Amalgamated Copper Company, so that, as they were shut down at different times, one was able to help the other. At certain periods the Washoe plant, the normal capacity of which is 10,000 tons, was reported to be treating 11,750 tons of copper ore daily, and later in the year the Great Falls plant treated at its full capacity 4,000 tons a day. The Pittsmont smelter, operated by the Pittsburg and Montana Copper Company, was not seriously affected, and treated an average of 300 tons of copper ore daily from its mine and from outside sources. The lead smelter of the American Smelting and Refining Company at East Helena only accepted ore from mining companies with which contracts had previously been made. Some ore was shipped during 1908 to Utah and Idaho smelters, but not in quantity to affect operations of smelters in Montana. The conservation of waste material, consisting of molten slag from the copper furnaces of the Colusa Parrot smelter, is of interest. It was possible for that establishment to build in 1908 about 800 feet of culverts with reenforced slag from the smelter operations. The company had previously used the slag to construct the foundation to a brick stack finished to a height of 352.5 feet. At the Great Falls smelter, of the Boston and Montana Company, a stack 506 feet high was completed. This, with the flue-dust chambers, is erected to render the sulphur and arsenical gases as little harmful as possible, besides conserving the flue dust. The company estimates an annual saving of products worth $180,000. The "smoke case," as it was called, between the farmers and the smelter at Anaconda, was settled in January, 1909, and no damages were awarded to the farmers.

Two great dams are being built on the Missouri River and three others are projected by the Great Falls Water, Power, and Transit Company. This company, with others whose plants are in operation on that river, supplies electric power and light to many mines, deep and placer, and provides power for several plants and reduction works.

Railroad building of importance to mining districts was performed by the Chicago, Milwaukee and St. Paul through a section of Missoula County, which should be greatly benefited. Grading was commenced by the Armstead and Gilmore Railroad from Armstead, Mont., to Gilmore and Salmon City, Idaho, its final destination. This line will help to develop mining property in Beaverhead County.

Montana has nineteen counties in which mine operators reported production of metals in 1908. Eighty-six mining districts have a production credited to them for 1908. Later in this report a brief review is given of each of the productive counties and districts.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1908, by counties.

County.	Gold.				Silver.		Copper.		Lead.		Zinc.		Total value.
	Placer.		Deep mines.										
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Fine ounces.*		*Pounds.*		*Pounds.*		*Pounds.*		
Beaverhead	117.31	$2,425	211.16	$4,365	38,954	$20,646	129,879	$17,144	80,610	$3,386	.....	.....	$47,966
Broadwater	196.84	4,069	7,050.80	145,753	25,502	13,516	833,803	110,062	286,102	12,016	.....	.....	285,416
Cascade	.....	.....	226.78	4,688	94,021	49,531	6,352	839	180,320	7,574	.....	.....	62,932
Chouteau and Flathead	198.19	4,097	12,616.84	260,813	22,689	12,025	.....	.....	1,014	43	.....	.....	276,978
Deerlodge	118.81	2,456	3,192.60	65,997	3,834	2,032	619	82	.....	.....	.....	.....	70,567
Fergus	.....	.....	36,818.02	761,096	10,773	5,710	.....	.....	.....	.....	.....	.....	766,806
Granite	617.50	12,765	3,883.35	80,276	450,068	238,536	74,317	9,810	142,455	5,983	.....	.....	347,370
Jefferson	77.83	1,609	6,648.85	137,444	1,047,157	554,993	338,331	44,660	1,747,463	73,393	.....	.....	812,099
Lewis and Clark	923.12	19,083	9,654.73	199,581	108,121	57,304	22,660	2,991	1,237,518	51,976	.....	.....	330,935
Madison	20,072.67	414,939	8,351.61	172,643	35,077	18,591	21,268	2,807	190,617	8,006	.....	.....	616,986
Meagher, Carbon, Park, and Ravalli	234.06	4,838	297.55	6,151	514	272	35,503	4,686	11,816	496	.....	.....	16,443
Missoula and Sanders	1,496.58	30,937	20.65	427	266	141	5,857	773	165	7	.....	.....	32,285
Powell	2,395.58	49,521	486.07	10,048	18,494	9,802	48,494	6,401	120,671	5,068	.....	.....	80,840
Silverbow	157.51	3,256	31,848.33	658,363	8,500,729	4,505,386	250,150,712	33,019,894	597,819	25,108	1,640,000	$77,080	38,289,087
	26,606.01	549,995	121,307.33	2,507,645	10,356,199	5,488,785	251,667,795	33,220,149	4,596,570	193,056	1,640,000	77,080	42,036,710

The following table shows, by counties, the tons of ore sold or treated, the number of deep mines selling or treating ore, the average total value per ton, and the average value per ton in gold and silver:

Tonnage of ore sold or treated, number of mines producing, and average value per ton of ores in Montana in 1907 and 1908, by counties.

County.	Ore sold or treated (short tons).		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1908.	Increase (+) or decrease (−).	1907.	1908.	1907.	1908.	1907.	1908.
Beaverhead	954	− 659	11	15	$47.05	$47.73	$28.14	$26.21
Broadwater	14,728	− 533	19	27	14.13	19.10	4.98	10.81
Cascade	1,103	− 2,794	17	15	41.28	57.05	36.44	49.43
Chouteau and Flathead	59,818	+ 9,768	2	3	5.60	4.56	5.60	4.56
Deerlodge	7,084	− 578	9	8	9.55	9.61	9.29	9.60
Fergus	197,697	+ 34,980	6	8	4.00	3.88	3.98	3.88
Granite	18,803	+ 2,151	21	23	22.33	17.79	21.57	16.95
Jefferson	61,687	+ 19,858	34	52	22.77	13.14	19.84	11.22
Lewis and Clark	32,737	− 62,540	38	44	7.18	9.52	6.56	7.84
Madison	11,672	− 146	50	90	20.67	17.16	19.69	16.23
Meagher, Carbon, Park, and Ravalli	520	− 1,294	4	6	22.18	22.30	13.88	12.33
Missoula and Sanders	313	− 296	4	4	36.21	4.21	7.12	1.72
Powell	848	− 3,103	10	12	25.59	36.77	23.32	23.25
Silverbow	3,858,058	+122,712	80	102	13.24	9.92	1.51	1.34
	4,266,022	+117,526	305	409	12.85	9.72	2.19	1.87

[a] Value per ton, placer product excluded.

Tonnage of ore to gold and silver mills and concentrating mills, with amount of gold and silver contained in bullion produced in Montana in 1908, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.		*Fine ounces.*	*Short tons.*
Beaverhead	3	$18		
Broadwater	119	6,581	52	6,155
Cascade	18	128	2	
Chouteau and Flathead	59,801	259,505	22,608	
Deerlodge	6,865	61,427	1,801	
Fergus	197,652	753,399	6,382	
Granite	6,767	31,391	59,059	
Jefferson	306	4,655	512	34,905
Lewis and Clark	24,556	120,423	2,604	
Madison	7,361	30,000	517	61
Meagher, Carbon, Park, and Ravalli	346	4,972	51	
Missoula and Sanders	300	276	18	
Powell	20	68	1	
Silverbow				3,028,007
	304,114	1,272,843	93,607	3,069,128

Mine production of gold, silver, and associated metals from Montana concentrates in 1908, by counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Broadwater	629	157.77	4,829	273,842	23,519	.....	$42,955
Deerlodge	6	3.40	8	39	.....	.....	79
Granite	102	.....	22,131	5,100	.....	.....	12,402
Jefferson	3,787	784.47	200,082	10,167	484,819	.....	143,964
Lewis and Clark	763	989.00	6,246	11,741	33,432	.....	26,709
Madison	625	1,433.45	2,520	11,061	41,307	.....	34,163
Missoula and Sanders	7	7.02	158	.....	165	.....	236
Powell	.....	.....	.....	.....	.....	.....	.....
Silverbow	879,410	20,609.47	5,445,318	170,829,613	545,111	1,640,000	25,961,539
	885,329	23,984.58	5,681,292	171,141,563	1,128,353	1,640,000	26,222,047

Mine production of gold, silver, copper, lead, and zinc from Montana crude ore shipped to smelters in 1908, by counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaverhead	951	210.29	38,945	129,879	80,610	.....	$45,518
Broadwater	8,454	6,574.69	20,595	559,961	262,583	.....	231,769
Cascade	993	199.69	87,551	103	145,490	.....	56,655
Chouteau and Flathead	17	63.28	70	.....	1,014	.....	1,388
Deerlodge	219	217.67	2,012	580	.....	.....	5,643
Fergus	45	372.31	4,391	.....	.....	.....	10,022
Granite	12,036	2,364.82	368,701	69,217	142,455	.....	259,417
Jefferson	26,466	5,639.21	846,509	328,164	1,261,989	.....	661,544
Lewis and Clark	7,081	2,840.28	99,011	10,919	1,204,086	.....	163,203
Madison	3,150	5,466.93	28,802	10,207	149,310	.....	135,895
Meagher, Carbon, Park, and Ravalli	174	57.03	445	35,503	11,816	.....	6,597
Missoula and Sanders	13	.24	33	5,857	.....	.....	795
Powell	828	482.78	18,242	48,494	120,671	.....	31,117
Silverbow	746,843	10,984.99	2,965,456	76,282,648	52,708	.....	11,870,294
	807,270	35,474.21	4,480,763	77,481,532	3,432,732	.....	13,479,858

The following table gives the number of mines, classified according to their chief products in 1908:

Number of producing mines, classified by chief products, in Montana in 1908, by counties.

County.	Gold placer mines.				Deep mines.									Total mines producing.
	Hydraulic.	Dredge.	Drift.	Total.	Gold.	Silver.	Copper.	Gold and silver.	Gold, silver, and copper.	Gold, silver, copper, and lead.	Gold, silver, and lead.	Silver and lead.	Total.[1]	
Beaverhead	5	.....	.....	5	2	.....	.....	1	6	6	.....	.....	15	20
Broadwater	5	1	1	7	.....	.....	1	11	2	[a] 6	7	.....	27	34
Cascade	.....	.....	.....	.....	.....	.....	.....	1	.....	3	8	3	15	15
Chouteau and Flathead	2	.....	.....	2	.....	.....	.....	2	.....	.....	1	.....	3	5
Deerlodge	5	.....	.....	5	.....	.....	.....	5	3	.....	.....	.....	8	13
Fergus	.....	.....	.....	.....	.....	.....	.....	8	.....	.....	.....	.....	8	8
Granite	6	.....	1	7	.....	1	.....	12	5	3	2	.....	23	30
Jefferson	12	.....	.....	12	1	.....	.....	9	13	8	16	5	52	64
Lewis & Clark	33	.....	.....	33	.....	.....	.....	16	4	[a] 14	8	2	44	77
Madison	15	3	.....	18	1	.....	.....	41	24	6	17	1	90	108
Meagher, Carbon, Park, and Ravalli	11	.....	2	13	.....	1	1	2	1	.....	.....	1	6	19
Missoula and Sanders	17	.....	1	18	.....	.....	.....	.....	3	.....	1	.....	4	22
Powell	32	.....	.....	32	.....	.....	.....	4	4	.....	3	1	12	44
Silverbow	5	.....	.....	5	.....	1	9	30	54	[b] 5	3	.....	102	107
	148	4	5	157	4	3	11	142	119	51	66	13	409	566

[a] One reported no gold.

[b] One reported zinc.

PRODUCTION BY COUNTIES.

BEAVERHEAD COUNTY.

Mine production of metals in Beaverhead County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	258.95	$5,353	328.47	$6,790	+ 69.52	+$1,437
Silver.....do....	67,456	44,521	38,954	20,646	−28,502	−23,875
Copper.....pounds..	129,195	25,839	129,879	17,144	+ 684	− 8,695
Lead.....do....	88,239	4,677	80,610	3,386	− 7,629	− 1,291
	.....	80,390	.....	47,966	.....	−32,424

Ten districts recorded production in 1908 from 15 deep mines. The output includes the gold of 5 placer producers. With the exception of 3 tons treated at an amalgamation mill, the remainder, 951 tons, was shipped to smelters. The placer operators in the county reported $2,425 in gold produced in 1908, against $4,469 in 1907. The ore produced was 659 tons less than in 1907, although four more producers reported. The average total value per ton of the ore, which in 1907 was $47.05, was $47.73 in 1908. The largest shipments of ore were made from the Indian Queen property in Utopia district and the Argyle property in the Vipond district. The Silver Fissure property, which was reported as having been equipped with 4 blast furnaces in 1907, did not operate, although some shipments of matte were reported as having been forwarded from the district.

Argenta district.—The Butte Argenta Mining Company during 1908 was occupied with development work consisting of deepening the shaft to 175 feet and drifting. Other producers were the Gladstone-Midnight and the Goldfinch-Dolphin properties.

Bannack district.—The output of gold and silver from this district was produced from placers on East Fork of Dyer's Creek and on May Creek and had a total value of $2,174.

Blue Wing district.—The Kent mine produced a small lot of lead-silver ore, and from the New Departure was shipped silver ore, containing small quantities of copper and lead. The latter property is developed by tunnels. The total output of the district consisted of 63 tons of ore, yielding $32 in gold, 6,368 ounces of silver, 1,055 pounds of copper, and 9,360 pounds of lead.

Bryant district.—Lessees developed ore in several properties in the district during 1908, and made some shipments, which aggregated 181 tons, yielding $560 in gold, 17,473 ounces of silver, 14,112 pounds of copper, and 54,005 pounds of lead.

Beaverhead district.—The Calumet and Montana Company, operating the Dark Horse property, which is developed by a shaft 125 feet and a tunnel 600 feet long, 300 feet of which was accomplished in 1908, produced and shipped to the smelter some copper ore containing silver and gold. The company is awaiting the completion of the railroad under construction from Armstead, Mont., to Gilmore, Idaho. The Monument Copper Company operated property on Bloody Creek and uncovered some copper ore, of which a trial shipment was made, yielding 10 per cent of copper and 4 ounces of silver per ton.

Elkhorn district.—The Ingersoll and Brick Pomeroy claims produced some lead-silver ore containing a small quantity of copper.

Polaris district.—Furnaces built to treat ores of the Silver Fissure mine were reported to have been operated in January. Eleven tons of copper matte, containing silver and gold, were shipped from Apex, on the Oregon Short Line Railroad.

Utopia district.—One car of copper ore, containing an average of 2.2 per cent of that metal, was shipped from the Greenstone claim. Lessees operating the Indian Queen property made regular shipments of 15 per cent copper ore, averaging about 4 ounces of silver. Some of the ore was treated in the furnaces installed on the Silver Fissure property in Polaris district.

Vipond district.—Ore shipped from the district in 1908 contained principally silver, with a little gold. The Benton Mining and Milling Company, operating the Argyle property, 6 miles south of Dewey, was the largest producer. The ore was desirable at the smelters as converter lining.

BROADWATER COUNTY.

Mine production of metals in Broadwater County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	3,611.68	$74,660	7,247.64	$149,822	+3,635.96	+$75,162
Silver.....do....	11,192	7,387	25,502	13,516	+ 14,310	+ 6,129
Copper.....pounds..	660,152	132,030	833,803	110,062	+ 173,651	− 21,968
Lead.....do....	143,570	7,609	286,102	12,016	+ 142,532	+ 4,407
	.....	221,686	.....	285,416	.....	+ 63,730

Ore was produced by 27 mine operators in 1908, amounting to 14,728 tons, a decrease of 533 tons from the output of 1907, but an increase of 8 in the number of operators. The total average value per ton increased from $14.13 in 1907 to $19.01 in 1908. Ores shipped to smelters aggregated 8,454 tons, which contained 6,574.69 ounces in gold, 20,595 ounces in silver, 559,961 pounds of copper, and 262,583 pounds of lead, yielding a total value of $231,769, and averaging $27.41 per ton. Crude ore, aggregating 6,155 tons, went to mills equipped with concentrators and yielded 629 tons of concentrates, containing 157.77 ounces of gold, 4,829 ounces of silver, 273,842 pounds of copper, and 23,519 pounds of lead. The concentrates were valued at $42,955, or at an average of $68.29 per ton. At gold and silver mills using amalgamation, 119 tons of ore were treated and produced bullion containing 318.34 ounces of gold and 52 ounces of silver, a total value of $6,609, or an average value of $55.54 per ton. The placers yielded in 1908 $4,069 in gold as against $6,018 in 1907.

Backer district.—Four deep mines and the same number of placers reported output aggregating $8,191 in gold, 230 ounces of silver, 812,814 pounds of copper, and 31,759 pounds of lead. All but $1,944 of the gold and 17 ounces of the silver, which was the placer output, was the yield of 6,874 tons of ore. The Eclipse-Argo mine was an

important producer of copper ore, one-fifth of which was of shipping grade, the rest being concentrated at the mill located on the property. The Slim Jim claim, equipped with a 1-stamp mill using amalgamation, yielded from its ore a small quantity of gold and silver.

Beaver Creek district.—The output of this district was produced by 5 deep mines and 1 placer, and consisted of $26,134 in gold, 19,314 ounces of silver, 7,056 pounds of copper, and 180,191 pounds of lead. About one-half of the ore, aggregating 455 tons, was treated at concentration mills and the remainder shipped direct to smelters. Shipments of ore made by lessees on the Little Olga property, located at the head of Weazle Gulch, consisted largely of lead-silver ore, in which there were 5 pounds of lead to every ounce of silver. Copper averaged about 0.7 per cent and gold $2 to each ton of ore. A similar ore was shipped from the Little Bonanza claim. From the Eclipse, Iron Age, and Edna properties ore was mined and shipped in which the gold equaled the silver in quantity, and the copper amounted to 3 pounds to each ounce of gold and silver. The East Pacific property was worked by the company and by lessees. It is equipped with a 75-ton mill using concentration and amalgamation. Concentrates and crude ore were shipped, containing lead, silver, gold, and copper.

Cedar Plains district.—In 1908, 10 mine operators reported production aggregating $110,181 in gold, 3,019 ounces of silver, 5,032 pounds of copper, and 46,778 pounds of lead. With the exception of the placer product, amounting to $791 in gold and 4 ounces of silver, the above amounts were produced from 6,524 tons of crude ore, all of which was shipped to smelters. The Keating Gold Mining Company, the largest operator, mined from the Keating and Ohio claims near Radersburg during five months of 1908 a sulphide iron ore, which is said to have averaged $16.82 in gold, a trace of silver, 43 per cent of iron, and 9.1 per cent of silica. This ore was exceptionally valuable to the copper smelters for its sulphur. To a depth of 250 feet in this property the oxidized ore extended, and to this depth it was worked by the former owners. The depth of the present workings is 365 feet. It is stated that the mine is furnishing smelters with 100 tons of ore daily, shipping from Toston, a station on the Northern Pacific Railroad.

Park district.—During 1908 operators of 9 quartz properties in the district produced 354 tons of ore, yielding a total output of $5,313 in gold, 2,939 ounces of silver, 8,901 pounds of copper, and 27,374 pounds of lead. Several of the claims were worked by lessees. Those productive were the John L., Little Giant, Crown Hill, Silver Wave, and New Era. The last claim, and that adjoining it, the Marietta, are developed by the same tunnel, 1,400 feet long. The shipping ore contains lead, silver, and gold.

CARBON COUNTY.

Near Chance the Second Chance Placer Company experimented on the Clark's Fork Creek sand and gravel, reporting encouraging results in making a magnetic iron concentrate from which was separated gold with a fineness of 0.960.

CASCADE COUNTY.

Mine production of metals in Cascade County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	575.95	$11,906	226.78	$4,688	− 349.17	−$7,218
Silver.....do....	197,124	130,102	94,021	49,831	−103,103	−80,271
Copper.....pounds..	.....	.....	6,352	839	+ 6,352	+ 839
Lead.....do....	355,720	18,853	180,320	7,574	−175,400	−11,279
	.....	160,861	.....	62,932	.....	−97,929

Operators of 15 properties in 1908, against 17 in 1907, reported a production of 1,103 tons of ore, a decrease of 2,794 tons from that reported in 1907. The total average value per ton increased from $41.28 in 1907 to $57.05 in 1908. Of the output, 993 tons were shipped to smelters and contained 199.69 ounces of gold, 87,551 ounces of silver, 103 pounds of copper, and 145,490 pounds of lead, which yielded a total value of $56,655, or an average value of $57.05 per ton. The remainder consisted of 92 tons of slag and 18 tons of ore treated by amalgamation.

Montana district.—Fourteen deep mines reported an output aggregating 1,011 tons of ore, which yielded $4,256 in gold, 87,553 ounces of silver, 103 pounds of copper, and 145,490 pounds of lead, a total value of $56,784, at an average value of $56.16 per ton. Over nine-tenths of this ore was shipped to smelters, and some of it shipped in 1908 was mined in 1907. The producing claims of note are the Alice and Hartley, Big Seven, Silver Belt, Broken Hill, Broadwater, Galt, Lexington Consolidated, Lizzie, Benton, Morning Star, Moulton, Ripple, and the Crandall and Ingersoll.

CHOUTEAU COUNTY.

Little Rockies district.—The Alabama mine was operated in 1908 by the Little Rockies Exploration Company, and the Mint property by the Ruby Gulch Mining Company. Both companies mined ore of similar character, containing only gold and silver. The output of 1908, compared with that of 1907, shows that the number of tons of ore mined and treated increased, but that the value per ton for the gold and silver decreased. Though several shipments of crude ore were made from the district in 1908, the bulk of the ore mined was treated at the cyanide mill of the Ruby Gulch Mining Company. Bullion reduced from the gold precipitates at the cyanide mills averaged about two parts of silver for one of gold. The most important ore deposits are in the porphyry replaced and cemented by quartz and pyrite, and are mined principally by the open-cut method. The ore falls to the bottom of the "glory holes" and is drawn through chutes into tunnels driven under the deposits from 100 to 200 feet below the outcrop of the ore bodies.

West Butte district.—This district, in the northwestern corner of the county, produced a shipment from the Eureka mine of lead ore containing silver and gold.

DEER LODGE COUNTY.

Deer Lodge County produced in 1908 gold valued at $68,453, 3,834 ounces of silver, and 619 pounds of copper—a total value of $70,567. The production of 1907 was gold valued at $75,569, 1,077 ounces of silver, 8,848 pounds of copper, and 4,106 pounds of lead—a total value of $79,268. Eight operators of deep mines in 1908, against 9 reporting in 1907, reported a production of 7,084 tons of ore, which was 578 tons less than the output in 1907, and was valued at $9.61 per ton for the gold and silver content. The larger part of the tonnage, or 6,865 tons was treated at gold and silver mills, yielding bullion containing $61,427 in gold and 1,801 ounces of silver. In addition to this bullion, there were produced 6 tons of concentrates, which yielded 3.40 ounces of gold, 8 ounces of silver, and 39 pounds of copper. Crude ore shipped direct to smelters aggregated 219 tons, yielding 217.67 ounces of gold and 2,012 ounces of silver. The placer production aggregated $2,456 in gold.

Georgetown district.—Four operators in 1908 reported the production of 6,819 tons of ore, aggregating $63,266 in gold, 2,282 ounces of silver, and 296 pounds of copper, worth a total of $64,514 at an average value of $9.46 per ton. The producers were the Cable, Gold Coin, and Southern Cross. The last has been a steady producer and produced the greatest quantity of bullion. The mine is developed by a vertical shaft 240 feet deep. The cyanide mill is of a daily capacity of 120 tons.

FERGUS COUNTY.

Mine production of metals in Fergus County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	31,316.48	$647,369	36,818.02	$761,096	+ 5,501.54	+$113,727
Silver.....do....	3,630	2,396	10,773	5,710	+ 7,143	+ 3,314
Copper.....pounds..	1,219	244	.....	.....	− 1,219	− 244
Lead.....do....	52,519	2,783	.....	.....	− 52,519	− 2,783
	.....	652,792	.....	766,806	.....	+ 114,014

Eight operators in 2 districts reported a production from deep mines in 1908 aggregating 197,697 tons of ore, which was an increase of 34,980 tons over the production of 1907. All of this ore, with the exception of 45 tons containing only gold and silver shipped direct to smelters, was treated at gold and silver mills, and yielded an average of $3.88 per ton in gold and silver. This value was ten cents per ton lower than the average of 1907. No placer operations were reported for 1908.

North Moccasin district.—The output of 4 deep-mine producers aggregated $681,365 in gold and 6,219 ounces of silver. The properties yielding this output extend along the southeast slope of the North Moccasin Mountains. The Barnes King Development Company, the largest operator in the district in 1908, owns approximately 200 acres adjoining the town of Kendall, which is at an altitude of 5,000

feet and is reached by wagon road from Lewistown, 20 miles south. The ore bodies are said to occur in irregular chambers, following the plane of a thick bedded limestone dipping 20° to 30° from the horizontal and overlain, where not eroded, by thin bedded limestone, sandstone, and shale. In the principal workings these ore bodies, so far as found, extending from the surface to a vertical depth of 400 feet, were largely worked out during the life of the old company. The largest tonnage of ore during 1908 was mined from open cuts on the north end of the property connected with the working shaft at the 200-foot level. The ore was trammed through the tunnel, which is 4,000 feet long, and connected with a tramway 5,200 feet in length. At the cyanide mill, during good weather, there were treated 200 tons of ore daily, yielding gold and silver averaging in value approximately $4 per ton. The Kendall and North Moccasin, adjoining properties, both produced during the year, the ore of the latter receiving treatment in the 500-ton cyanide mill of the Kendall Company. Development was carried on in other parts of the district, notably on the Abbey, Golden Links, and Golden Discovery properties.

Warm Springs district.—A large tonnage of ore was reported from this district during 1908, principally by one company, and all but 45 tons were treated at gold and silver mills. The Gold Reef 200-ton mill was operated by lessees during 1908, but not at full capacity. Ore treated in the mill was mined principally from open cuts above the working tunnels, of which there are about 7,000 feet. Small shipments of gold-silver ore were made from other properties of the district.

FLATHEAD COUNTY.

Libby district.—Much of the placer gold produced in this district is 0.926 to 0.945 fine. The output of 1908 came principally from Libby Creek. No ore shipments were reported from the deep mines. The principal properties are the Snowshoe and Shaughnessy Hill. On the former a 250-ton lead concentrator has been built. The operators of the Victor, Empire, and Porcupine properties on Granite Creek, of the Kearney on Rainey Creek, and of the Montana Silver-Lead Company on Leigh Creek, reported development work.

GRANITE COUNTY.

Mine production of metals in Granite County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	3,335.51	$68,951	4,500.85	$93,041	+1,165.34	+$24,090
Silver.....do....	456,096	301,023	450,068	238,536	− 6,028	− 62,487
Copper.....pounds..	44,311	8,862	74,317	9,810	+ 30,006	+ 948
Lead.....do....	71,237	3,776	142,455	5,983	+ 71,218	+ 2,207
	.....	382,612	.....	347,370	.....	− 35,242

Reports from 23 deep mines of this county in 1908, 2 more than in 1907, showed an increase of 2,151 tons over the production of 1907. The output was 18,803 tons in 1908, averaging in total value per ton $17.79, of which $16.95 was for the gold and silver, the balance being for copper and lead contained in concentrates and crude ore shipped to smelters. The larger part, or 12,036 tons of ore, was shipped direct to smelters, and yielded 2,364.82 ounces of gold, 368,701 ounces of silver, 69,217 pounds of copper, and 142,455 pounds of lead. The remainder of the above total tonnage, aggregating 6,767 tons, was treated in gold and silver mills and yielded bullion containing 1,518.53 ounces of gold and 59,059 ounces of silver. There were also produced at these mills, in addition to the bullion, 102 tons of concentrate, which yielded 22,131 ounces of silver, 5,100 pounds of copper, but no gold. The output of gold from placer operations aggregated $12,765 and 177 ounces of silver.

First Chance district.—The output of 11 mining companies, including 3 placer operators, aggregated $24,667 in gold, 1,581 ounces of silver, and 1,001 pounds of copper. All of the ore, aggregating 857 tons, was shipped to smelters. Of the total output of the district only $895 in gold and 11 ounces of silver are credited to the placers. The lessees on the First Chance and the Lead King properties mined ore in which the gold was equal to the silver ounce for ounce. Other properties reporting production were the Cascade, Free Coinage, Shamrock, and Sierra. Placer gold credited to this district was washed from gravels in Bear Gulch.

Flint Creek district.—Eleven mine operators in this district reported in 1908 a yield aggregating $26,215 in gold, 436,154 ounces of silver, 63,003 pounds of copper, and 54,526 pounds of lead. All of the product, with the exception of $2,257 in gold and 15 ounces of silver credited to placers, was produced by deep-mine operators who shipped 10,708 tons of ore to smelters and treated at gold and silver mills 3,722 tons of ore, which yielded, besides the gold and silver bullion, some concentrate containing copper and silver. The Hope mill at Philipsburg was operated in April after several months of idleness. It is equipped with 10 stamps and pan amalgamation. Silver bullion and concentrates were produced, and a quantity of siliceous silver-copper ore was shipped direct to smelters. The Granite-Bimetallic, Hobo, Trout, Redemption, Headlight, and Royal Gold properties were also producers. From the Franklin Hill or Kentucky mine iron ore was mined from the surface and shipped as flux to the smelters at Anaconda and Butte.

Red Lion district.—At the cyanide mill of the Milwaukee Gold Extraction Company an important tonnage of gold and silver ore was treated by lessees working the Hannah group of claims.

South Boulder district.—Reports were received from 4 deep mines and 3 placers in this district, which aggregated an output of $21,448 in gold, 12,252 ounces of silver, 10,313 pounds of copper, and 87,929 pounds of lead. At the head of Gold Creek and from Rock Creek good results were recorded from placer operations. Among the deep mines the Sunday and the Gold Reef were producers of gold and silver ore, and the Nonpariel and the Brooklyn produced lead-silver ore containing a small percentage of copper. The Gold Reef is equipped with a mill containing 6 quadruple discharge stamps capable of treating 20 tons of ore per day.

JEFFERSON COUNTY.

Mine production of metals in Jefferson County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	15,525.09	$320,932	6,726.68	$139,053	−8,798.41	−$181,879
Silver.....do....	775,159	511,605	1,047,157	554,993	+ 271,998	+ 43,388
Copper.....pounds..	238,822	47,764	338,331	44,660	+ 99,509	− 3,104
Lead.....do....	1,414,952	74,992	1,747,463	73,393	+ 332,511	− 1,599
	.....	955,293	.....	812,099	.....	− 143,194

There were 52 deep-mine operators reporting in 1908—18 more than in 1907. The output of ore amounted to 61,687 tons, an increase of 19,858 tons over the output of 1907. The total average value per ton decreased from $22.77 in 1907 to $13.14 in 1908, and the gold and silver value of this ore, which in 1907 was $19.84, decreased to $11.22 in 1908. The largest proportion of the ores, aggregating 34,905 tons, treated at concentration mills, were siliceous in character, and contained gold, silver, copper, and lead. These ores yielded 3,787 tons of concentrate, containing 784.47 ounces of gold, 200,082 ounces of silver, 10,167 pounds of copper, and 484,819 pounds of lead, which aggregated $143,964 in value, at an average value of $38.01 per ton. Of the remainder of the ore milled, 306 tons were treated at gold and silver mills, and 26,466 tons were shipped direct to smelters. The latter yielded 5,639.21 ounces of gold, 846,509 ounces of silver, 328,164 pounds of copper, and 1,261,989 pounds of lead, which aggregated in value $661,544, at an average value per ton of $24.99. The placer production of this county was valued at $1,609 in gold, against $2,950 in 1907.

Amazon district.—Three mine operators reported the shipment of 55 tons of ore to smelters, which yielded $120 in gold, 1,095 ounces of silver, 200 pounds of copper, and 18,811 pounds of lead, a total value of $1,517, at an average value of $27.58 per ton. The small shipments constituting the above output were made from the Australian, the Freiberg, and the Morning Star claims.

Boulder district.—Placers of several gulches yielded small quantities of gold, and shipments of ore from lode mines contained lead, silver, and gold.

Cataract district.—Fourteen mines in 1908 yielded 10,486 tons of ore, three-fourths of which was treated at concentration mills. The remainder was shipped direct to smelters, except a small quantity treated at gold and silver mills. The total yield was $52,644 in gold, 91,502 ounces of silver, 74,660 pounds of copper, and 445,442 pounds of lead, aggregating $129,704 at an average value of $12.37 per ton. The Comet mine exceeded in production all others as to tonnage of lead-silver ore and of concentrates containing copper and gold. The operators of the Klondike shipped ore similar to that of the Comet. The properties producing ore containing lead, silver, and a little gold were the H. T., the Pearl, the Lexington, and the Toga. The chief metal contents of the Buckeye, Custer, Eva May, and Crystal mines were copper and silver, and the ore of the Ruby, the Wasson, and the Columbia contained only gold and silver.

Colorado district.—The total output from 13 operators aggregated 2,288 tons of ore, containing $6,560 in gold, 50,612 ounces of silver, 165,424 pounds of copper, and 41,028 pounds of lead, worth $56,943, at an average value of $24.89 per ton. All of this output was shipped direct to smelters. The operators of the Bald Headed Eagle and the Peacock claims shipped ore containing principally lead with silver and gold. The Black Jack and the Alta Gregory mines contained the same metals with copper in addition. In the ores of the Dailey and the Bertha mines only copper, silver, and gold were reported.

Elkhorn district.—The principal producer of the district was the Elkhorn mine, which yielded an ore containing lead, silver, gold, and a trace of copper. Two-thirds of the ore mined was treated in the concentration mill, the remainder being shipped with the concentrate direct to smelters. Construction work on a new mill by the Electro Metals Company for the treatment of tailings by the Baker-Burwell process was in progress during 1908, but details as to its success were not reported. The Golden Curry Consolidated Company shipped oxidized iron ore containing an average of 0.5 per cent of copper and some silver and gold. The ore was used as a flux. A 100-ton cyanide plant is under construction on the property. The Montana Central also produces iron ore containing a small quantity of gold.

Lump Gulch district.—Eleven operators of deep mines reported the shipment of 525 tons of ore to smelters and the treatment of 160 tons at gold and silver mills, which yielded a small quantity of gold and silver bullion. The total yield from these ores was $12,152 in gold, 12,146 ounces of silver, 735 pounds of copper, and 14,233 pounds of lead, aggregating in value $19,284, at an average value of $28.15 per ton. The Little Nell, Liverpool, King Solomon, Last Hope, Mammoth, and White Pine mines all produced lead-silver ore, and the Duluth and the Mocking Bird mines on the North Fork of Warm Springs Creek produced gold and silver, with a small quantity of copper.

Whitehall district.—The principal part of the output made by this district came from the shipment of ore made by two operators and from placer mining. The latter was largely reported from Little Pipestone Creek, the gold averaging about 903 in fineness. The ore shipped was reported from the Columbia, Anna, and Avon claims near Cardwell, and contained gold, silver, and small quantities of lead. The Golden Sunlight property was preparing to operate in 1909.

LEWIS AND CLARK COUNTY.

Mine production of metals in Lewis and Clark County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
PLACERS.						
Gold.....fine ounces..	1,237.72	$25,586	923.14	$19,083	− 314.58	− $6,503
Silver.....do..	438	289	200	138	− 178	− 151
DEEP MINES.						
Gold.....fine ounces..	24,980.80	516,523	9,654.73	199,581	−15,332.07	−316,942
Silver.....do....	105,638	108,925	107,861	57,196	− 57,177	− 51,729
Copper.....pounds..	27,207	5,473	22,500	2,991	− 4,707	− 2,482
Lead.....do....	1,000,337	53,018	1,237,518	51,976	+ 237,181	− 1,042
	.....	709,814	.....	330,935	.....	−378,879

The number of reports received from deep-mine operators in this county in 1908 was 44, or 6 more than in 1907. The yield of ore came from a greater number of mines in 1908, but the output decreased 62,540 tons from the production of 1907, and in 1908 aggregated 32,737 tons, averaging in total value $9.52 per ton, of which the value in gold and silver was $7.84. The greatest tonnage of this output, 24,556 tons in quantity, was treated at gold and silver mills, and yielded bullion containing 5,825.45 ounces of gold and 2,604 ounces of silver. In addition to this bullion, there were produced at these mills 763 tons of concentrates, containing 989 ounces of gold, 6,246 ounces of silver, 11,741 pounds of copper, and 33,432 pounds of lead. The remainder of the tonnage was shipped direct to smelters and aggregated 7,081 tons of crude ore, which yielded 2,840.28 ounces of gold, 99,011 ounces of silver, 10,919 pounds of copper, and 1,204,086 pounds of lead. This ore shipped to smelters aggregated $163,203 in value, at an average of $23.05. The placers of the county yielded $19,083 in gold and 260 ounces of silver, against $25,586 in gold and 438 ounces of silver in 1907.

Ottawa district.—At Marysville, in the Ottawa district, the Drumlummon property was idle, except for a small amount of work done by lessees. The ore of the Piegan-Gloster mine was treated in the Bald Butte mill, resulting in a lead concentrate and gold and silver bullion. On Silver Creek some accumulated tailings were treated by the cyanide process and placer mining in various gulches was carried on on a small scale. The Bald Butte mine, located at the head of Dog Creek and on the edge of Ottawa district, produced ore containing lead, gold, and silver. The greater part of the gold and silver in this ore is caught on amalgamation plates in the 40-stamp mill, and the remainder is secured with the lead in the concentrate. The Silver Bell claim of the Strawberry Mining Company produced ore similar to that of the Bald Butte.

Stemple district.—North of Marysville, in the Stemple district, the Bell Boy and the Klondyke properties produced a lead-gold and silver ore, which yielded bullion and a lead concentrate, the result of mill tests.

Greenhorn district.—Near Austin, in the Greenhorn district, an iron flux and lead ore were shipped from the Bessie mine. The Pittsburg-New York Mining Company, operating the Umatilla properties 8 miles west of Helena, has about completed a cyanide mill. Southwest of Helena, the Arrowhead and Old Dominion properties produced an ore yielding lead, gold, and silver. This ore was treated in a 2-stamp mill equipped with a concentrator, producing bullion and lead concentrate. Numerous small shipments of ore from this vicinity were mined from surface deposits or sorted from old dumps.

Unionville district.—In the Unionville district, the Springhill and the Whitlatch properties were the largest producers. The output of these two properties consists chiefly of bullion and concentrate, with the principal values in gold and silver.

Vaughan district.—Near Rimini, in the Vaughan district, the Perseverance, the Neagle, and the Last Dollar were the largest placer producers. The operators of the Valley Forge mine shipped to smelters a lead, silver, and gold ore.

MADISON COUNTY.

Mine production of metals in Madison County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
PLACERS.						
Gold.....fine ounces..	9,462.59	$195,609	20,072.67	$414,939	+ 10,610.08	+$219,330
Silver.....do....	1,569	1,035	3,238	1,716	+ 1,669	681
DEEP MINES.						
Gold.....fine ounces..	8,953.05	185,076	8,351.61	172,643	− 601.44	− 12,433
Silver.....do....	72,263	47,694	31,839	16,875	− 40,424	− 30,819
Copper.....pounds..	33,854	6,771	21,268	2,807	− 12,586	− 3,964
Lead.....do....	90,037	4,772	190,617	8,006	+ 100,580	+ 3,234
	.....	440,957	.....	616,986	.....	+ 176,029

Ninety reports in 1908, against 50 in 1907, for the deep mines of Madison County showed a yield of 11,672 tons of ore, which was 146 tons less than reported in 1907. The total value per ton of this ore decreased from $20.67 in 1907 to $17.16 in 1908. The gold and silver content of the ore in 1908 was valued at $16.23 against $19.69 in 1907. The largest part of the tonnage was 11,369 tons of siliceous ore, the remainder being 281 tons of lead ore and 22 tons of copper ore. About two-thirds of the total tonnage, 7,361 tons in quantity, was treated at gold and silver mills and yielded bullion containing $30,000 in gold and 517 ounces of silver. The remainder of the tonnage of crude ore, 3,150 tons, with the exception of 61 tons treated at concentration mills, was shipped direct to smelters and yielded 5,466.93 ounces of gold, 28,802 ounces of silver, 10,207 pounds of copper, and 149,310 pounds of lead. The aggregate value of this smelting ore was $135,895, at an average of $43.14 per ton. The placer production of 1908 doubled the output of 1907 and aggregated $414,939 in gold and 3,238 ounces of silver. It also exceeded the output of 1906, which was $391,044 in gold and 2,023 ounces of silver. This county still leads in placer output, yielding 75 per cent of the total output of Montana, or 26,606.01 ounces of gold. The yield is produced largely in Alder Gulch district, where the three electric dredges of the Conrey Placer Mining Company were in operation during the greater part of the year.

Alder Gulch district.—This district, which had been so long famous for its rich placers, showed a rapid decline in its output of gold after all the ground available had been worked over by hydraulic and sluicing methods. The decrease was variable and continued to the end of the year 1907. Soon after the dredge was substituted for other hydraulic methods the question of getting enough cord wood for fuel with which to operate became an important one, and finally it was necessary to use coal, which proved a costly item. The solution of the problem came when a hydro-electric power plant was erected on the opposite side of the range from Ruby Valley, and a line was constructed to bring in the power. The dredge built in 1906 was equipped with electrical machinery and it proved so successful that it was decided to equip the other dredges; two of the dredges are said to have a capacity of handling 3,000 cubic yards of

gravel daily, and the third dredge, larger than the others, has almost equaled the combined capacity of the two. In 1908 one of these dredges worked near the Poor Farm and within 2 miles of the terminus at Alder of the Ruby Valley branch of the Northern Pacific Railroad; the second opposite the old Conrey ranch house; and the third began work directly at the mouth of Alder Gulch Canyon. One corporation owns these dredges and the placer ground for a distance up the canyon of about 7 miles. Much of it is virgin territory, too flat and with the bed rock too deep for the ordinary methods of sluicing. Therefore, there is much interest attached to the future. The ore from the deep mines yielded chiefly gold and silver, and 376 tons of it were shipped direct to smelters, and 207 tons were treated at gold and silver mills.

Lower Hot Springs district.—Small shipments of ore from a number of properties leased during 1908 yielded principally gold and silver.

Mineral Hill district.—The output reported by 12 deep mines aggregated 5,796 tons containing $53,445 in gold, 3,956 ounces of silver, 11,315 pounds of copper, and 15,103 pounds of lead, the total valued at $57,670, at an average of $9.95 per ton. Nine-tenths of the tonnage was treated at gold and silver mills, from which some concentrate containing copper and lead, in addition to the gold and silver, was produced. Only 127 tons of crude ore were shipped direct to smelters. The Garnet, the Boss Tweed, and the Clipper were the principal producers.

Norwegian district.—Four mine operators reported the production of 135 tons of ore, yielding at smelters $7,463 in gold, 890 ounces of silver, 1,079 pounds of copper, and 15,572 pounds of lead, aggregating $8,102, at an average gross value of $60.01 per ton.

Ramshorn district.—Reports from 6 lode mining claims and from 8 placer operators indicated a yield of $10,091 in gold, 3,203 ounces of silver, 174 pounds of copper, and 364 pounds of lead. Two-thirds of the output of gold and silver was contained in shipments to smelters.

Rabbit district.—Five operators of deep mines and 1 placer operator reported an aggregate of $2,499 in gold, 506 ounces of silver, and 14,448 pounds of lead. The lead, gold, and silver, with the exception of $287 in gold produced by placers, was contained in ores shipped to smelters.

Sand Creek district.—The Whip-poor-will claims, near Sappington, produced a few tons of smelting ore containing gold and silver.

Sheridan district.—Reports from 6 mines gave an aggregate output of 441 tons of ore, three-fourths of which was treated at gold and silver mills; the remainder was shipped direct to smelters. The output aggregated $7,447 in gold, 1,615 ounces of silver, and 467 pounds of copper, the total being valued at $8,365, at an average value of $18.97 per ton. Operators of the Tamarack, the Wild Cat, and several smaller mines reported production.

Silver Star district.—From 11 deep mines was reported an aggregate output of 1,049 tons of ore, containing $33,491 in gold, 2,660 ounces of silver, 2,038 pounds of copper, and 13,004 pounds of lead, the total being valued at $35,716, at an average of $34.05 per ton. All of this product, with the exception of 3 tons, treated at gold and silver mills, was shipped direct to smelters. The Broadway and Bowery, the largest producer of crude ore to smelters in 1908, was reported as producing principally gold, with some copper and silver. Its shaft is

650 feet deep and its tunnel 1,100 feet long. The Hudson and Iron Rod produced a rich ore, containing high values in gold.

Summit district.—Five deep mines produced 1,164 tons of ore, nine-tenths of which was treated at gold and silver mills, the remainder being shipped to smelters. The total output contained $19,063 in gold, 5,569 ounces of silver, and 116 pounds of copper, the total being valued at $22,030, at an average of $18.92 per ton.

Tidal Wave district.—Thirteen mine operators reported the treatment of 1,454 tons of ore and old tailings, containing $11,935 in gold, 6,866 ounces of silver, 3,935 pounds of copper, and 144,689 pounds of lead, the total being valued at $22,171, at an average of $15.25 per ton. Nearly all the mines produced lead, besides gold and silver.

Upper Hot Springs district.—Only 2 operators reported output, including the lessees shipping a gold and silver ore from the Revenue property.

Washington district.—The operators of the Lehigh and the George McKee mines were the principal shippers of gold and silver ore. The 5-stamp mill on the latter property was idle.

MEAGHER COUNTY.

Four producers reported in 1908 an output of 176 tons of ore This was the same number reporting in 1907, but the tonnage decreased 1,294 tons. The total average value per ton of these ores in 1907 was $22.18; it increased in 1908 to $31.41, the larger portion of which was for copper and lead, leaving only $1.96 for gold and silver. The output consisted of 20 tons of siliceous ores, 78 tons of copper ore, and 78 tons of lead ore. The larger part, consisting of lead and copper ore, 156 tons in quantity, was shipped direct to smelters and contained 0.84 ounce of gold, 431 ounces of silver, 35,503 pounds of copper, and 11,816 pounds of lead, aggregating in value $5,428 and averaging $34.79 per ton. The placer output consisted of $1,342 in gold and 5 ounces of silver.

Castle Mountain district.—Small shipments of lead-copper ore characterized the production of this district.

Musselshell district.—Near Delpine the Clara Barton mine produced a copper ore containing small quantities of silver and gold. Placers in the district yielded gold 942 in fineness. The total output, including the placers and deep mines, aggregated $4,472 in value.

MISSOULA COUNTY.

Mine production of metals in Missoula County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
PLACERS.						
Gold.....fine ounces..	2,010.85	$41,568	1,496.58	$30,937	−514.27	−$10,631
Silver.....do....	89	59	57	30	− 32	− 29
DEEP MINES.						
Gold.....fine ounces..	17.27	357	.24	5	− 17.03	− 352
Silver.....do....	6,027	3,978	25	13	− 6,002	− 3,965
Copper.....pounds..	86,200	17,240	4,713	622	−81,487	− 16,618
Lead.....do....	9,000	477	.....	.....	− 9,000	− 477
	.....	63,679	.....	31,607	.....	− 32,072

One deep mine return in 1908, against 4 returns to the Survey in 1907, reported 10 tons of copper ore against 609 tons in 1907. The placer output also decreased from a production of $41,568 in gold in 1907 to $30,937 in gold in 1908. No new developments of note were reported from this county in 1908, although considerable work is known to be going on in the various mines. The Chicago, Milwaukee and St. Paul Railroad completed construction of its line through the county into Idaho. This may stimulate mining to some extent.

Cedar Creek district.—Cedar Creek and its tributaries yielded during 1908 $24,551 in gold and 51 ounces of silver. There were 11 operators reporting, the majority working only with sluices and several others with hydraulic and sluices. The gold ranges in fineness from 0.869 to 0.986.

Iron Mountain district.—Nine Mile Creek and its tributaries produced largely from placer operations, the gold here having an average fineness of about 0.980. The work is principally performed by hydraulic and sluicing.

PARK COUNTY.

The output of ore in 1908 was 344 tons, valued at $6,068 for its gold and silver, against an output in 1907 of 1,700 tons, valued at $31,890. The average value per ton in 1908 was $18.17, the larger part consisting of gold. The placer output consisted of $1,335 in gold and 6 ounces of silver.

New World district.—The Cooke City smelter was not in operation either in 1907 or in 1908 for lack of ore. There were mined, but not shipped, from the Hudson and Boulder property 200 tons of ore, averaging per ton $6 in gold and 32 ounces of silver and containing 32.5 per cent of lead.

Sheepeater district.—Sheepeater district and Emigrant Creek produced most of the placer gold recorded for 1908.

POWELL COUNTY.

Mine production of metals in Powell County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
PLACERS.						
Gold.....fine ounces..	1,181.61	$24,426	2,395.58	$49,521	+1,213.97	+$25,095
Silver.....do....	160	106	251	133	+ 91	+ 27
DEEP MINES.						
Gold.....fine ounces..	3,807.93	78,717	486.07	10,048	−3,321.86	− 68,669
Silver.....do....	20,255	13,368	18,243	9,669	− 2,012	− 3,699
Copper.....pounds..	1,397	279	48,494	6,401	+ 47,097	+ 6,122
Lead.....do....	164,911	8,740	120,671	5,068	− 44,240	− 3,672
	.....	125,636	.....	80,840	.....	− 44,796

In Powell County there were 848 tons of ore produced, consisting of 96 tons of siliceous ore, 182 tons of copper ore, and 570 tons of lead ore. The total production compared with that of 1907 showed a decrease of 3,103 tons. The total average value per ton in 1908 was

$36.77 against $25.59 in 1907. The larger part of the value in 1908 consisted in gold and silver contained in the ore to the amount of $23.25 per ton. The larger part of the tonnage, or 828 tons, was shipped direct to the smelters and yielded 482.78 ounces of gold, 18,242 ounces of silver, 48,494 pounds of copper, and 120,671 pounds of lead, aggregating in value $31,117, at an average value per ton of $37.58. The remainder of the ore, consisting of 20 tons, was treated at a gold and silver mill.

Coloma district.—Placers and several lode claims in the Coloma district, of which Garnet is the post-office, produced gold, silver, and copper.

Ophir district.—The largest part of the output credited to this district was from deep mines in Snowshoe Gulch, which is 4 miles east of Ophir, a spur of the mountains separating the two localities. The Elliston Copper Mining Company, one of the important operators to ship in 1908, mined from the Flagstaff property an average shipping grade of copper ore containing gold and silver. It is developing the Utah, an adjoining property. The Ladysmith, another property near by, was a producer of copper ore. The Wall Street property was being developed. Placers in this district yielded $1,382 in gold and 8 ounces of silver.

Pioneer district.—Dealers in placer gold and several producers on Gold Creek and its tributaries reported a production of gold averaging in fineness 878 and amounting to $36,734 in gold and 208 ounces of silver.

Washington Gulch district.—Placers located in the vicinity of Helmville, which is the post-office of the district, aggregated $9,526 in gold and 24 ounces of silver.

Zozell district.—Nine miles east of Deer Lodge, at the head of Rocker Gulch, the Black Eyed May Mining Company produced some gold and silver ore. The Emery was the largest producer of lead ore containing gold and silver, the Emma Darling shipping similar ore.

RAVALLI COUNTY.

There were no deep mines in Ravalli County reporting production in 1908. The placer output consisted of 100.04 ounces of gold and 7 ounces of silver, valued at $2,072.

SANDERS COUNTY.

No production for Sanders County was recorded in 1907, but 3 operators in 1908 reported a production of 303 tons of ore, of which 3 tons were shipped to a smelter and the remainder was treated at gold and silver mills and produced bullion, which contained 13.39 ounces of gold and 18 ounces of silver. In addition to the bullion, 7 tons of concentrate, yielding 7.02 ounces of gold, 158 ounces of silver, and 165 pounds of lead, were shipped to smelters.

Spring Gulch district.—The Carter Mining and Milling Company developed during the first part of the year. It has an incline shaft 125 feet deep. The ore contains gold, copper, lead, and silver. The Glen Metals Company, near Superior, retained ore taken out of the mine in doing development work. It is opened by a tunnel 2,200 feet long. The operators of the Iron Mask have completed their

tunnel for a length of 1,296 feet, and are said to have encountered ore of milling grade. The operators of the Swastika mine made a test shipment of copper ore.

Prospect Creek district.—The operators of the Arlington mine developed some lead, silver, and copper ore, but made no shipments. In October, 1908, the first section of 5 stamps was completed and 15 more were being added to the mill of the Shamrock property. The ore produced contains gold, silver, and lead.

SILVERBOW COUNTY.

Mine production of metals in Silverbow County, Mont., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	34,367.59	$710,441	32,005.84	$661,619	− 2,361.75	− $48,822
Silver.....do....	7,516,659	4,960,995	8,500,729	4,505,386	+ 984,070	− 455,609
Copper.....pounds..	218,836,627	43,767,325	250,150,712	33,019,894	+31,314,085	−10,747,431
Lead.....do....	223,676	11,855	597,819	25.108	+ 374,143	+ 13,253
Zinc.....do....	243,100	14,343	1,640,000	77,080	+ 1,396,900	+ 62,737
	.....	49,464,959	.....	38,289,087	.....	−11,175,872

The increases shown in this table were largely made in November and December, 1908, and the totals are aggregates for the year as reported by 102 deep-mine operators, including a number of lessees working surface ores. There were 80 operators reporting in 1907. There were mined and treated 3,858,058 tons of ore in 1908. This is an increase of 122,712 tons over the production of 1907. The total average value per ton decreased from $13.24 in 1907 to $9.92 in 1908. The larger part of this value is for the copper contained in the ore, as the gold and silver, which was valued at $1.51 in 1907, decreased to $1.34 in 1908. The greater part, or 3,817,212 tons, was copper ore; the next greatest tonnage, 28,133 tons, consisted of zinc ore; 12,694 tons were siliceous ore, which averaged well in silver and contained small quantities of copper; and 19 tons were classed as lead ore. Over nine-tenths of the total ore mined, or 3,028,007 tons, was treated at concentration mills, producing 879,410 tons of concentrates, which yielded at the smelters 20,609.47 ounces of gold, 5,455,318 ounces of silver, 170,829,613 pounds of copper, 545,111 pounds of lead, and 1,640,000 pounds of zinc, aggregating in value $25,961,539, at an average value per ton of $29.52. The concentrates containing lead and zinc with associated gold and silver, were shipped to lead and zinc smelters; the remainder of the concentrates was treated at copper plants. The remainder of the total ore, or 746,843 tons, was treated at smelters and yielded 10,984.99 ounces of gold, 2,965,456 ounces of silver, 76,282,648 pounds of copper, and 52,708 pounds of lead, aggregating in value $11,870,294, at an average per ton of $15.89. Included in the totals for the smelting ores are 83,208 tons of slag and flue dust, from which 3,038,451 pounds of copper, with gold and silver, were extracted. The precipitates from mine waters and old tailings yielded 4,301,674 pounds of copper. The placer production aggregated 157.51 ounces of gold and 25 ounces of silver, valued at $3,269.

Divide Creek district.—The deep mines in the Divide Creek district, in the southern part of the county, yielded some ore in 1908, and placers in the northwestern part of the county, as well as in the southern part, yielded some gold.

Butte district.—During the first three months of 1908 all of the mines of the Butte district, except those of the Boston and Montana, the North Butte, and the Pittsburg and Montana companies, and the Original Consolidated properties, were closed down completely. The June floods contributed largely to a lessened output during the months of June and July, especially affecting the Boston and Montana Company by reason of the fact that the Great Northern tracks were completely washed away between Butte and Great Falls, where the plant is located. Production became normal in September, continuing to the close of 1908, with an output equal to that of any similar period in the history of the district. Continued fires in the Anaconda and Never Sweat mines interfered somewhat with the operations in those properties, but as the ore was lifted through the adjoining shafts the tonnage was not greatly lessened. During the last months of 1908 the daily output of ores from the Butte mines was approximately as follows: Amalgamated Company, 12,500 tons; Original Consolidated, 1,100 tons; Butte Coalition, 1,100 tons; Pittsburg and Montana, 400 tons. The North Butte Company lifted in December an average of 1,400 tons a day, although the records show that on one or two occasions 1,700 tons of ore were hoisted in twenty-four hours. At the close of 1908 the yield of ore from all the mines is said to have aggregated about 16,000 tons per day, and the number of men employed in the Butte district was about 19,000.

Many new companies in the county, organized when copper was 20 cents a pound and more, ceased operations when the metal reached the low price. It is doubtful whether any of these companies can be resurrected unless the price of copper returns to 20 cents per pound.

In 1908 a modern electrically driven dredge was installed at Rocker, 4 miles west of Butte, on the property of the British-Butte Mining Company. The company is reported to have prospected the placer gravel to a considerable depth. The placer is said to be located near the center of an area of old lake beds. The deep shaft sunk on the property is to serve in developing the Blue Bird lode, a fissure in granite, which once was productive of rich silver ore.

NEVADA.

By C. Naramore and C. G. Yale.

PRODUCTION.

In 1908 Nevada produced gold, silver, copper, lead, and zinc valued at $18,818,228, as compared with $17,591,486 in 1907, an increase for 1908 of $1,226,742. The yield of gold was 549,682.27 fine ounces, valued at $11,362,941, and that of silver was 9,508,464 ounces with a commercial value of $5,039,486. Of copper 15,598,788 pounds were produced, valued at $2,059,040; the lead output was 7,245,619 pounds valued at $304,316; and the zinc product was 1,115,851 pounds, valued at $52,445. There was a decided increase in the output of dry or siliceous and of copper ores, but a decrease in tonnage in the cases of lead, zinc, and copper-lead ores. The total number of tons of ore treated in 1908 was 1,425,532 tons as compared with 723,581 tons in 1907, an increase for 1908 of 701,951 tons. The quantity of dry or siliceous ore treated was 951,880 tons in 1908, an increase of 323,379 tons over the output of 1907. Of copper ores there were 434,887 tons treated in 1908, an increase of 423,787 tons. The largest quantity of copper ore—430,014 tons—came from White-pine County; the largest quantity of siliceous ore—388,716 tons—was from Nye County.

In 1908 the average value of siliceous ore in gold and silver was $16.58 per ton, as compared with an average value of $25 per ton in 1907. As noted, a very much larger quantity of siliceous ore was treated in 1908 than in 1907, the grade, however, was of considerably lower average. In 1907 much high-grade ore was shipped, but in 1908 the ore was treated to a large extent at local mills, so that lower-grade ores could be utilized. The average value per ton in gold and silver of the copper ores was 26 cents in 1908, as compared with $6.65 in 1907. This marked difference was due to the treatment of large quantities of very low-grade copper ores at Ely. The average values in gold and silver per ton of the lead ores was $11.56 in 1908, as compared with $9.86 in 1907. The copper-lead ores yielded an average per ton in gold and silver of $10.05 in 1908, which average was $16.87 in 1907.

In 1907, copper-zinc ores furnished 5 tons of ore; copper-lead-zinc ores, 889 tons; and zinc-lead ores 11,224 tons; but in 1908 there was no tonnage from ores of these classifications.

The quantity of ore treated at gold and silver mills in 1908 was 818,656 tons, yielding $5,967,682 in gold and $2,991,459 in silver. This showed a metallic recovery of $7.29 per ton in gold and $3.65 per ton in silver. From this ore treated at gold and silver mills were obtained 4,157 tons of concentrates yielding $486,178 in gold and $959,699 in silver. This was an average of $116.96 per ton in gold and of $230.86 per ton in silver.

The 818,656 tons of crude milling ore thus yielded a total of $6,453,860, or an average of $7.88 per ton in gold; and a total of $3,951,158, or an average of $4.83 per ton, in silver. The total gold and silver in both crude ore and concentrates was $10,405,018, and an average total recovery of $12.71 per ton in both metals was shown from the ores treated at gold and silver mills.

Of crude ore sent to concentrating mills there were 435,114 tons, which yielded an average of $4.79 per ton in all metals. From this ore were obtained 39,055 tons of concentrates, yielding $94,857 in gold, $29,094 in silver, 14,842,233 pounds of copper, valued at $1,959,175, and 39,678 pounds of lead, valued at $1,666. The total value of the concentrates was $2,084,792 in all metals, at $53.38 per ton.

The crude ore shipped to smelters was 128,084 tons. This yielded $4,624,263 in gold, an average of $36.10 per ton, and $1,027,861 in silver, an average of $8.03 per ton. The total gold and silver value in the ore smelted was $5,652,124, an average value in both metals of $44.13 per ton. This crude smelting ore yielded 756,555 pounds of copper, valued at $99,865, and 7,205,941 pounds of lead, valued at $302,650. Hence the total values in the ore smelted were, in all metals, $6,054,639, which was an average value of $47.27 per ton.

There were 43,678 tons of old tailings worked, yielding $110,210 in gold, an average of $2.53 per ton, and $30,306 in silver, an average of 69 cents per ton.

In 1908 reports were received from 421 producing mines. Of the producing mines, 28 were placers, of which 3 were hydraulic mines, 11 drift mines, and 14 sluicing or dry washing properties; the producing deep mines numbered 393, of which 202 were gold mines; 86, silver; 18, copper; 26, lead; 2, zinc; 27, gold and silver; 8, gold-silver-lead; 2, silver-copper; 2, silver-copper-lead; and 20, silver-lead. This classification is based on the chief product of the mines.

The placers of Nevada yielded 3,857.96 fine ounces of gold, valued at $79,751, and 2,013 ounces of silver, valued at $1,067. The largest output of placer gold and silver came from Nye County, where the placers at Round Mountain made a total yield valued at $55,298 in gold and silver. The next placer field in importance was at Manhattan, in the same county, where gold and silver valued at $16,371 was obtained by drifting and dry washing.

The statement of production of Nevada for 1907 and 1908, showing increase and decrease, and value at average commercial price for each year, is as follows:

Mine production of gold, silver, and associated metals in Nevada in 1907 and 1908.

Year.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Pounds.*	
1907	585,311.14	$12,099,455	7,083,603	$4,675,178	1,782,571	$356,514
1908	549,682.27	11,362,941	9,508,464	5,039,486	15,598,788	2,059,040
Increase(+) decrease(−)	−35,628.87	−736,514	+2,424,861	+364,308	+13,816,217	+1,702,526

Year.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
1907	6,271,341	$332,381	2,168,783	$127,958	$17,591,486
1908	7,245,619	304,316	1,115,851	52,445	18,818,228
Increase (+) decrease (−)	+974,278	−28,065	−1,052,932	−75,513	+1,226,742

GOLD.

The total gold production for Nevada in 1908 was 549,682.27 fine ounces, valued at $11,362,941, a decrease of 35,628.87 fine ounces in quantity and of $736,514 in value, as compared with the output of the year 1907. Esmeralda County made the largest gold yield, 289,527.76 fine ounces, valued at $5,985,070. Of this total for the county the district of Goldfield yielded $4,880,251, which was nearly 43 per cent of the total gold yield of the State for the year. Nye County produced $3,074,586 in gold, of which $1,624,491 came from Tonopah district, $645,457 from Bullfrog, $264,232 from Manhattan, and $439,377 from Round Mountain. Esmeralda County led in rank of gold output, with $5,985,070 to its credit; followed by Nye County, with $3,074,586; Storey, with $599,617; Lincoln, with $518,306; Clark, with $280,166; Humboldt, with $273,227, and other counties with smaller outputs. The largest source of gold was siliceous ore, from which were derived 534,050.81 fine ounces; the copper ores yielded 4,629.58 ounces; lead ores, 7,129.35 ounces, and copper-lead ores, 14.57 ounces. The placer gold yield was 3,857.96 ounces. The placer gold yield in 1908 increased by 1,184.03 ounces over that of 1907, but a falling off is apparent for the same period in the yield from all other sources but copper ores.

The production from different kinds of ore in 1908, with increase or decrease as compared with that of 1907, is shown in the following table:

Source of gold product in Nevada in 1908, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.					Grand total.
		Siliceous ore.	Copper ores.	Lead ores.	Copper-lead ores.	Total.	
Churchill		2,656.76				2,656.76	2,656.76
Clark		13,546.07	4.40	2.56		13,553.03	13,553.03
Douglas	89.93	71.88				71.88	161.81
Elko	47.17	8,861.38	.29	12.43		8,874.10	8,921.27
Esmeralda	57.23	289,262.47	26.75	181.31		289,470.53	289,527.76
Eureka		2,416.38		5,923.28		8,339.66	8,339.66
Humboldt	14.51	13,192.69	7.31	2.85		13,202.85	13,217.36
Lander		412.30		97.52	.63	510.45	510.45
Lincoln		24,440.50	19.98	598.78	13.79	25,073.05	25,073.05
Lyon	16.93	4,249.21				4,249.21	4,266.14
Nye	3,435.16	144,995.98		301.96		145,297.94	148,733.10
Storey		29,006.47				29,006.47	29,006.47
Washoe		682.48	2.32			684.80	684.80
White Pine	197.03	256.24	4,568.53	8.66	.15	4,833.58	5,030.61
Total	3,857.96	534,050.81	4,629.58	7,129.35	14.57	545,824.31	549,682.27
Increase (+) or decrease (−)	+1,184.03	−19,380.27	+3,664.02	−1,667.83	−19,130.28	−36,812.90	−35,628.87

In 1907 there were 71.60 fine ounces derived from copper-lead-zinc ores, and 226.93 fine ounces from lead-zinc ores.

SILVER.

The silver yield of Nevada in 1908 was 9,508,464 fine ounces, valued at $5,039,486, as compared with 7,083,603 ounces, valued at $4,675,178, in 1907. This was an increase in quantity in 1908 of 2,424,861 ounces and in value of $364,308. Nye County produced 7,632,813 fine ounces, valued at $4,045,391, out of the total for the State, and of this value the district of Tonopah produced $3,801,370.

The next largest silver producer was Storey County, followed in order by Esmeralda, Churchill, and Lincoln counties. The siliceous ore yielded 8,953,654 fine ounces in 1908, which was 2,476,130 more ounces than were derived from that source in 1907. The yield of silver from copper ores was less by 52,291 ounces in 1908 than in 1907, notwithstanding the large increase in tonnage of copper ores. The lead ores yielded 482,018 fine ounces in 1908, or 199,808 fine ounces more than in 1907. The source of silver product, by kinds of ore, with increase or decrease, is shown in the following table:

Source of silver product in Nevada in 1908, by kinds of ore, by counties, in fine ounces.

County.	Placers.	Deep mines.					Grand total.
		Siliceous ore.	Copper ores.	Lead ores.	Copper-lead ores.	Total.	
Churchill	.....	265,340	.....	85	.....	265,425	265,425
Clark	.....	11,081	485	9,647	.....	21,213	21,213
Douglas	11	21	.....	.....	.....	21	32
Elko	6	34,232	2,432	10,810	.....	47,474	47,480
Esmeralda	7	187,058	1,438	250,085	.....	438,581	438,588
Eureka	.....	19,572	.....	120,979	.....	140,551	140,551
Humboldt	9	35,128	1,175	3,240	.....	39,543	39,552
Lander	.....	36,278	.....	12,679	3,281	52,238	52,238
Lincoln	.....	147,830	874	49,432	34,479	232,615	232,615
Lyon	8	12,611	.....	.....	.....	12,611	12,619
Nye	1,936	7,625,754	.....	5,123	.....	7,630,877	7,632,813
Storey	.....	542,017	.....	.....	.....	542,017	542,017
Washoe	.....	260	44	.....	.....	304	304
White Pine	36	36,472	22,873	19,938	3,698	82,981	83,017
Total	2,013	8,953,654	29,321	482,018	41,458	9,506,451	9,508,464
Increase (+) or decrease (−)	+167	+2,476,130	−52,291	+199,808	−130,355	+2,414,694	+2,424,861

In 1907 copper-zinc ores produced 6 fine ounces; copper-lead-zinc ores produced 32,516 fine ounces; and lead-zinc ores produced 28,408 fine ounces.

COPPER.

The production of copper in Nevada in 1908 was 15,598,788 pounds, valued at $2,059,040; in 1907 it was 1,782,571 pounds, valued at $356,514. This was an increase in quantity in 1908 over 1907 of 13,816,217 pounds and in value of $1,702,526. All of the 14 mineral-producing counties in Nevada produced copper in 1908 except Douglas and Storey. By far the largest output of copper, 14,839,493 pounds, was derived from White Pine County, practically all of which came from Ely district. Lincoln County produced 277,727 pounds; Elko County, 130,197 pounds; and Lyon County, 100,849 pounds. All the other counties produced less than 100,000 pounds each. The total quantity of copper ores treated in 1908 was 434,887 tons; in 1907 only 11,100 tons were reported. The copper ore sent to concentrating mills amounted to 434,376 tons, which made 38,961 tons of concentrates, yielding, aside from other metals, 14,842,233 pounds of copper, valued at $1,959,175, or an average per ton of concentrates of $50.29 in copper value. This shows that from the crude ore 1.7 per cent of copper was recovered, and from concentrate 9 per cent. From ores shipped to smelters 756,555 pounds of copper, valued at $99,865, were recovered. The mining operations at Ely, the principal copper district of the State, are being extended, and a

still larger output may be expected for the year 1909. Of copper-lead ores 2,217 tons were produced. There are 18 mines producing copper ore in the State, 2 producing silver-copper ore, and 2 producing silver-copper-lead ore.

LEAD.

The production of lead in 1908 was 7,245,619 pounds, valued at $304,316, as compared with 6,271,341 pounds in 1907, valued at $332,381. Ten of the 14 metal-producing counties of the State were producers of lead in 1908. The leading producers were Eureka County, with a production of 2,330,048 pounds; Whitepine County, with 1,595,882 pounds; and Lincoln County, with 1,095,000 pounds. There are 26 lead mines in Nevada, 8 gold-silver-lead mines, and 20 silver-lead mines. The quantity of lead ores treated in 1908 was 34,755 tons and of copper-lead ores 2,217 tons. From copper ores sent to concentrating mills 39,678 pounds of lead were recovered, and from smelting ores 7,205,941 pounds were obtained. The lead ores yielded 7,129.35 fine ounces of gold and 482,018 fine ounces of silver during treatment. The copper-lead ores yielded 14.57 ounces of gold and 41,458 ounces of silver.

ZINC.

The zinc product of Nevada in 1908 was 1,115,851 pounds, valued at $52,445, which, as compared with the output of 1907, was a decrease of 1,052,932 pounds in quantity and of $75,513 in value. All the producing zinc mines are in Yellow Pine district, in Clark County. The ore was sorted and shipped crude to plants in Kansas for reduction.

The following table shows the tonnage of different classes of ore sold or treated in Nevada in 1908, in short tons:

Subdivision of tonnage of ore sold or treated in Nevada in 1908, by counties, in short tons.

County.	Dry or siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	Total.
Churchill	2,073	15	2	.....	.....	2,09
Clark	54,218	202	701	1,793	.....	56,91
Douglas	271	.....	.....	.....	.....	27
Elko	24,851	595	992	.....	.....	26,43
Esmeralda	206,935	96	1,390	.....	.....	208,42
Eureka	1,474	.....	26,724	.....	.....	28,19
Humboldt	7,845	3,575	87	.....	.....	11,50
Lander	1,489	.....	419	.....	90	1,99
Lincoln	134,180	20	1,631	.....	1,887	137,71
Lyon	13,760	360	.....	.....	.....	14,12
Nye	388,716	.....	488	.....	.....	389,20
Storey	113,908	.....	.....	.....	.....	113,90
Washoe	958	10	.....	.....	.....	96
Whitepine	1,202	430,014	2,321	.....	240	433,77
Total	951,880	434,887	34,755	1,793	2,217	1,425,53
Increase (+) or decrease (−)	+323,379	+423,787	−2,582	−2,549	−27,966	+701,95
Average value per ton in gold and silver	$16.58	$0.26	$11.56	.....	$10.05	$11.4

In 1907 copper-zinc ores furnished 5 tons, copper-lead-zinc ores furnished 889 tons, and zinc-lead ores furnished 11,224 tons.

Number of mines, classified by chief product, in Nevada in 1908, by counties.

County.	Nonproducing.	Gold placer mines.				Deep mines.										Total producing mines.
		Hydraulic.	Drift.	Dry washing and sluicing.	Total.	Gold.	Silver.	Copper.	Lead.	Zinc.	Gold and silver.	Gold-silver-lead.	Silver-copper.	Silver-copper-lead.	Silver-lead.	Total.	
Churchill	63	...	...	...	...	6	8	...	...	...	1	...	...	...	1	16	16
Clark	72	...	...	...	...	8	....	4	6	2	1	...	...	...	...	21	21
Douglas	22	...	...	3	3	2	...	...	...	...	...	...	...	...	...	2	5
Elko	52	...	...	3	3	11	3	5	3	...	3	...	...	...	4	29	32
Esmeralda	139	...	1	2	3	48	15	2	4	...	3	1	1	....	2	76	79
Eureka	17	...	...	...	...	6	1	....	2	...	6	4	...	...	3	22	22
Humboldt	146	...	...	1	1	19	8	1	...	...	1	...	...	...	1	30	31
Lander	31	...	...	...	...	6	14	...	...	...	1	1	...	1	4	27	27
Lincoln	42	...	...	...	...	1	4	1	3	...	2	1	...	....	2	14	14
Lyon	26	...	...	1	1	10	....	1	...	...	...	...	...	...	...	11	12
Nye	145	3	7	4	14	53	20	....	1	...	8	1	...	....	2	85	99
Storey	19	...	...	...	...	18	8	...	...	...	...	...	...	...	...	26	26
Washoe	23	...	...	...	...	8	....	1	...	...	...	...	...	...	...	9	9
Whitepine	51	...	3	....	3	6	5	3	7	...	1	....	1	1	1	25	28
	848	3	11	14	28	202	86	18	26	2	27	8	2	2	20	393	421

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1908, by counties.

County.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Pounds.*	
Churchill	2,656.76	$54,920	265,425	$140,675	5,212	$688
Clark	13,553.03	280,166	21,213	11,243	62,719	8,279
Douglas	161.81	3,345	32	17	...	...
Elko	8,921.27	184,419	47,480	25,164	130,197	17,186
Esmeralda	289,527.76	5,985,070	438,588	232,452	32,500	4,290
Eureka	8,339.66	172,396	140,551	74,492	79,985	10,558
Humboldt	13,217.36	273,227	39,552	20,963	54,598	7,207
Lander	510.45	10,552	52,238	27,686	11,144	1,471
Lincoln	25,073.05	518,306	232,615	123,286	277,727	36,660
Lyon	4,266.14	88,189	12,619	6,688	100,849	13,312
Nye	148,733.10	3,074,586	7,632,813	4,045,391	167	22
Storey	29,006.47	599,617	542,017	287,269	...	...
Washoe	684.80	14,156	304	161	4,197	554
Whitepine	5,030.61	103,992	83,017	43,999	14,839,493	1,958,813
	549,682.27	11,362,941	9,508,464	5,039,486	15,598,788	2,059,040

County.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Churchill	1,690	$71	...	...	$196,354
Clark	765,142	32,136	1,115,851	$52,445	384,269
Douglas	...	...	...	...	3,362
Elko	478,881	20,113	...	...	246,882
Esmeralda	590,119	24,785	...	...	6,246,597
Eureka	2,330,048	97,862	...	...	355,308
Humboldt	38,024	1,597	...	...	302,994
Lander	169,857	7,134	...	...	46,843
Lincoln	1,095,000	45,990	...	...	724,242
Lyon	...	...	...	...	108,189
Nye	180,976	7,601	...	...	7,127,600
Storey	...	...	...	...	886,886
Washoe	...	...	...	...	14,871
Whitepine	1,595,882	67,027	...	...	2,173,831
	7,245,619	304,316	1,115,851	52,445	18,818,228

MINING INDUSTRY IN NEVADA IN 1908.

The mines of Nevada produced gold, silver, copper, lead, and zinc valued in 1908 at $18,818,228, an increase of $1,226,742 over the value of the production of 1907. There was a very materially reduced yield of gold and some reduction also in lead and zinc values. The silver increased in quantity, and to less extent in values. The main increase in value, however, was in the copper output, and this, together with the increase in silver, far overcame the decrease in gold, lead, and zinc and left the handsome balance to the credit of the State noted above. The marked decrease in gold output in 1908, amounting to $736,514, was due entirely to the reduction in yield of the Goldfield district mines, as explained in detail in the subsequent chapter on Esmeralda County.

The most notable features in the progress of the mining industry in Nevada in 1908 were the largely increased values obtained in Tonopah district, in both gold and silver, but especially in gold; the greatly reduced gold output from the Goldfield mines; the marked increase in quantity and values of copper derived from the extensive mining operations in Ely district; and the very satisfactory yield from several districts which have recently reached a productive stage of some importance, together with the decided increase in some districts which have heretofore not been noted as producers.

The districts of Goldfield and Tonopah are the most productive and the best known in the State, and a comparison of the yield in the last two years may be of interest. In 1907 Goldfield produced a total of $8,455,725, of which all but a small fraction was in gold; in the same year the output of Tonopah district was valued at $4,739,966, of which $1,185,628 was in gold, $3,544,788 in silver, and a small fraction in lead and copper. In 1908 the value of the production of Goldfield was $4,896,799, practically all in gold, and Tonopah produced $5,425,861, of which $1,624,491 was in gold and $3,801,370 in silver. This considerable increase in the output of Tonopah district was effected in spite of a declining silver market. With silver at 66 cents, as it was in 1907, the values of the product of Tonopah would have been $6,358,272.

There is still more or less complaint in some districts that it is difficult to obtain money readily for the development work, which is absolutely necessary to prove the value of properties. Since the financial panic of 1907, mining shares in unproductive or speculative properties have been in little demand. As a consequence, large numbers of operations in the prospecting stage have ceased operations altogether, and doubtless many of them will never resume work. Some of the smaller and newer districts in southwestern Nevada have, for the reasons stated, been virtually abandoned, for the time being at least. Even with these generally prevailing conditions, however, a very large amount of development work is in progress in mines in various districts which have never as yet made any output, but the prospects of which are encouraging. This report shows that numbers of new districts, as well as mines, have come into the productive stage during 1908, and that very few upon which honest work has been done have been closed. The "wildcat" feature of mining in the State is being gradually eliminated.

There were 18 mining districts in Nevada in 1908 whose production was valued at over $100,000 each.

In Churchill County the value of the total output in 1908 showed a decrease as compared with that of 1907, owing to the reduced yield of Fairview district and notwithstanding the fact that the output of Wonder district was three times as large as in 1907. A small gold production was reported from the new Jessup district in 1908.

Clark is a new county, formerly the southern part of Lincoln County. There were decreased outputs from both Searchlight and Yellow Pine districts. The latter district was the source of the entire zinc production of the State in 1908. A smelter has been completed at Nelson in the El Dorado Canyon district.

In Elko County there was an increased output of gold from the new camp of Gold Circle, and of silver and lead from the Tecoma district.

Esmeralda County, notwithstanding its large decrease in gold output already noted, held first rank as the chief gold-producing county of the State. There was more than four times as much silver mined in 1908 as in 1907 and nearly six times as much lead. There are 22 producing districts in the county. At Goldfield the large new mill was started up in 1908, and has been highly successful. Hornsilver is an old district recently reopened, producing silver and lead and showing an increased production in 1908. Lone Mountain and Lucky Boy districts also have recently begun to produce silver and lead; the latter is on the old Bodie road, and much active development is going on there. Rawhide district, producing for the first time in 1908, yielded an output valued at $147,280. In Silver Peak district there was a gain in value of production of nearly $1,000,000 over that of 1907.

Eureka County showed a large decrease in the output of all metals in 1908, although maintaining first place in the production of lead.

In Humboldt County there was a large increase in the production of gold in 1908, but a decrease in output of the base metals. Seven Troughs district yielded an increase of $130,000 in value over the production of 1907, and Chafey district produced for the first time in 1908.

In Lander County the old Reese River district made an output from several mines. In the Cortez district a large new cyanide plant was erected in 1908.

Lincoln County was subdivided into Lincoln and Clark counties in 1908, the latter being the southern half of the old county. There was a decreased production in Caliente and Delamar districts; but in Ferguson district the value of the output was over $500,000, an increase of about $80,000 over that of 1907, and the Pioche district made an increase in value of yield of about $150,000 in 1908. The Bamberger Delamar property in Delamar district, which has been an important producer, was reported permanently closed down, the grade of ore having become too low for profitable mining. The old district of Pioche is expected to become more productive through extensive operations planned by several of the larger companies.

Lyon County had few producing mines in 1908, and the output for the year showed a decrease as compared with that of 1907.

Nye County was the most productive in the State in 1908, with an increase in value of yield of nearly $2,000,000, due mainly to operations at Tonopah. In addition to increased production at Tonopah, the value of the production in Bullfrog district in 1908 was $806,917, or about $600,000 more than in 1907; in Round Mountain district the value of the production was nearly $500,000, or an increase of $276,000 over that of 1907; and Manhattan district made a production valued at $234,000 more than in 1907. Bellehellen, Johnnie, and Lodi Valley districts all appeared as new producers in 1908. There were about 100 producing mines in Nye County in 1908.

The value of the production in Storey County was $524,000 more than in 1907, and the yield of the famous old Comstock Lode is again nearing the $1,000,000 mark.

Washoe County showed a decreased output in 1908.

White Pine County made the largest increase in output of all the counties in Nevada, owing to the production of copper ores in Ely district, valued at $2,046,232 in 1908. The old White Pine or Hamilton district produced considerable lead; the placers of Osceola district were productive, and the Ward district appeared as a producer in 1908.

REVIEW BY COUNTIES.

CHURCHILL COUNTY.

Sixteen mines in Churchill County in 1908 produced 2,090 tons of ore, containing 2,656.76 fine ounces of gold, valued at $54,920, and 265,425 fine ounces of silver, valued at $140,675, a total of $195,595. The ore also carried 5,212 pounds of copper, valued at $688, and 1,690 pounds of lead, valued at $71, which made the combined value of all the metallic product of the county for the year $196,354. This was only a little more than one-third of the total value for 1907, and represented a decrease of $388,643 in total value, of which $97,460 was in gold and $291,942 was in silver.

Siliceous ores furnished the entire gold output and all of the silver production, except $45, which was won from lead ores. Of the 16 producing mines, 9 produced less than $1,000.

Boyer district.—The American Nickel Company, operating in the Boyer or Table Mountain district in the northeastern part of the county, continued development work.

Eagleville or Hot Springs district.—This district lies just south of Fairview, near the Esmeralda County line. A small shipment of ore was made from the Harry Mann and Maine mines, which are developed by a 90-foot shaft and a 450-foot tunnel. Development work on the property of the Eagle Mining Company consists of about 7,000 feet of tunnels, shafts, drifts, and stopes. The Prince Albert mine, the Olive mine, and a number of small properties were being developed during the year.

Eastgate district.—The Eastgate district lies about 24 miles due east of Fairview, on the western slope of the Desatoya Mountains, and within a few miles of the Lander County line. Some silver ore was shipped during 1908 from the Northern mine, which is developed by a 123-foot shaft and a 500-foot tunnel.

Fairview district.—From this district operators of 4 mines shipped 1,521 tons of crude ore to the smelters during 1908, which carried $43,771 in gold and $97,304 in silver, in addition to a small lead content, valued at $71, making the total value of the metallic product $141,146, or almost three-fourths of the total for Churchill County, yet this was equal to only one-fourth of the total value of the output of 1907 from this district. A falling off in the production from the Nevada Hills Mining Company accounted for most of the decrease. This company operated its mine the entire year and shipped the ore to the smelters at Salt Lake. The shaft was sunk 210 feet deeper, to a depth of 420 feet, and about 3,000 feet of tunneling and drifting was done during 1908. The Fairview Eagle Mining Company's ore carried nearly four times as much value in silver as in gold; the shipments from the other mines of the district averaged about $2 in silver to $1 in gold. This company was active the entire year and did approximately 1,220 feet of development work. The incline shaft was 200 feet deep at the end of the year. The Eagle Nest Fairview Company also shipped in 1908. The mine of the Cyclone Mining Company was idle during 1908. On the Ridge mine of the Dromedary Hump Mines Company leasing companies were at work. The total development work at the end of the year included 5 shafts, aggregating 925 feet, and 600 feet of tunnels and crosscuts. The Day mine and the Highland Chief were developed. At the Fairview Central mine the tunnel was extended. The Mispah mine is developed by a 280-foot shaft, a 450-foot tunnel, and 800 feet of drifts, crosscuts, and raises. The Nevada Fairview Mining Company, the Nevada East Extension Mining Company, and the Pittsburg Fairview Mining Company continued development, and similar work was in progress at the Reliance Nevada Fairview. The Fairview Consolidated Mines Company did not operate last year. Development work on the Wyoming-Fairview mines included a 212-foot incline shaft, with drift and crosscut.

Jessup district.—Jessup is a new district in the north central part of Churchill County, about 35 miles south of Lovelock. Small shipments of gold-bearing ore were made during 1908 by the Stewart Mining Company and from the Gold King group. The Jessup Mines Company had 3 sets of lessees working during 1908. The White Canyon Gold Mining Company deepened its shaft.

Whiteplains district.—Whiteplains is situated about 5 miles west of Huxley, a station on the Southern Pacific Railroad. Smelter shipments of gold-bearing ore were made from the Desert Queen mine, which was active throughout the year. At the Hawskins and Hunter group there is a 210-foot incline shaft.

Wonder district.—Six producing mines in 1908 won $7,486 in gold and $41,969 in silver from 408 tons of ore. This production was nearly three times as large as that of 1907, which was derived from 3 mines. The Jack Pot Consolidated Mining Company was the heaviest shipper from this district in 1908. The developments at this property consist of a 310-foot shaft and 600 feet of tunnel work. Shipments were continued from the Nevada Wonder mine, and during the year 1,150 feet of development work was done. The Queen Wonder Mining Company made a shipment in 1908 and lessees began to develop the property. One small lot of ore was shipped by the Vulture

Mining Company. Among the nonproducing operators of the district were the Battleship Mining Company and the Dictator Mining Company. A 600-foot tunnel and 700 feet of drifts were reported from the Golden Dawns mine.

Whitecloud district.—The Nevada United Mining Company shipped a small quantity of copper ore to the Salt Lake smelters from this district. This mine is developed by a 2,750-foot tunnel, 1,400 feet of which was driven during 1908. The company reported cutting a 24-foot ledge of zinc-bearing ore at a point 1,350 feet from the adit of the main tunnel.

CLARK COUNTY.

Clark County, formerly the southern half of Lincoln County, was formed by dividing the latter county at the Third Standard Parallel south of the Mount Diablo Base Line.

During 1908 the mines of Clark County produced $291,409 in precious metal values. There were 13,553.03 fine ounces of gold, valued at $280,166, and 21,213 fine ounces of silver, valued at $11,243. In addition, the mines of the county produced 62,719 pounds of copper, valued at $8,279; 765,142 pounds of lead, valued at $32,136, and the entire zinc product of the State, 1,115,851 pounds, valued at $52,445. Twenty-one mines produced 56,914 tons of ore consisting of 54,218 tons of dry or siliceous ore, 202 tons of copper ores, 701 tons of lead ores, and 1,793 tons of zinc ores. The siliceous ores were the source of nearly all the gold and more than half of the silver output of the county. The remainder of the silver was derived from lead and copper ores.

There were 28,724 tons of ore sent to gold and silver mills, from which the bullion returns amounted to $215,199 in gold and $3,14[illegible] in silver, an average recovery of $7.60 per ton. Three thousand tons of crude ore were shipped to the smelters, carrying $11,011 in gold and $6,426 in silver, an average of $5.81 per ton in precious metal values, in addition to the base metal values.

The cyaniding of 25,190 tons of old tailings yielded $53,956 in gold and $1,671 in silver, an average recovery of $2.21 to the ton.

Bunkerville district.—From this district, sometimes called the Copper King, the Nevada Nickel and Copper Company, operating the Key West mine, reported a shipment of ore carrying nickel and platinum in addition to the gold, silver, and copper values. The mine developments include a 300-foot shaft and about 5,000 feet of tunnels and crosscuts.

Crescent district.—No production was reported from the Crescent district, and but little development work was done during 1908. The Lucky Dutchman Mining and Milling Company were drifting from the bottom of their 325-foot shaft. The Nippeno Mining Company carried on development work till August. The total work is about 5,000 feet, including a 535-foot shaft. The Oro Nevada mine, the Star and White Duck mines, and the Shreveport mine were developed.

Gold Butte district.—This district includes the territory in the southeastern corner of Clark County, which is surrounded by Virgin River on the west, Colorado River on the south, and the Arizona line on the east, and extends north as far as St. Thomas. Reports re-

ceived by the Survey indicate increased activity in development work during 1908, consisting largely of tunnel driving for prospecting purposes. The Cedar Basin Gold Mining Company operates the Hustler and the Crown groups. The Lincoln Gold Mining Company began operations late in 1908. The property is equipped with a 12-ton amalgamating and concentrating mill. The Nevada Gold Butte Mining Company, Ltd., the Southern Nevada Copper Company, the operators of the Standard mines, and the Lincoln Copper Company reported tunnel work.

Las Vegas district.—No production was made by the placer mines in the vicinity of Las Vegas, and the lode mines in that immediate section were also idle throughout the year.

Logan district.—There was but one small shipment of copper ore from the Logan district tributary to Moapa.

El Dorado Canyon district.—The Success Mining Company shipped some ore to the Needles smelter from its mine at Nelson. The metallic production from this district showed a very large decrease as compared with the yield of 1907, as the operators were placing the ore on the dumps awaiting the completion of the 150-ton smelter erected by the Santa Barbara-Searchlight Mining Company. This company also developed the Rich Hill mine by 700 feet of work. Considerable ore was extracted and hauled to the new smelter. The El Dorado-Searchlight Company did not produce during 1908. Operations by the Fortuna Gold Mining Company and at the Jennings mine resulted in placing ore on the dump for future treatment. The Wallace Gold Mining Company reported development work.

Searchlight district.—There were 52,193 tons of ore treated from the Searchlight district during 1908, yielding $271,573 in gold, $5,768 in silver, 14,954 pounds of copper, and 44,857 pounds of lead, with a total value of all metals of $281,199. This represented an increased tonnage and quantity of silver and lead produced, but the gold and copper output diminished nearly one-half; and this decline, coupled with the lower prices of silver, copper, and lead, caused a decrease of $217,748 in the total values recovered.

In 1908, 28,724 tons of milling ore yielded bullion containing $215,199 in gold and $3,146 in silver. Two hundred and seventy-nine tons of smelting ore contained $10,117 in gold, and $1,056 in silver in addition to the copper and lead content. The re-treatment of 23,190 tons of old tailings made a further recovery of $46,257 in gold and $1,566 in silver.

The Homestead Mining and Milling Company, operating the Duplex and Good Hope mines, reported a decreased output owing to the destruction of their mill and cyanide plant by fire on June 1. Two thousand feet of development work was accomplished during the year. The Quartette Mining Company, the largest producer in the county, operated its Golden Treasure and Copper King mines along with the 40-stamp amalgamation mill the entire year. The new 150-ton cyanide plant was completed July 15 and operated the remainder of the year. The company's development work includes 2,035 feet of incline shafts and 9,587 feet of drifts. There were no operations on the Rambler group.

The Searchlight-Parallel Gold Mining Company sent ore to the Cyrus Noble Mining Company's 10-stamp plate-amalgamation mill for treatment. The mine is opened by a 500-foot incline shaft. The

Cyrus Noble Company now have 1,500 feet of drifts on various levels. The Blackhawk Consolidated Mining Company continued development work. The property is equipped with a 10-stamp mill and concentrating tables. The Boulder Mining and Milling Company and the New Era Mining Company did several hundred feet of sinking and drifting during 1908. The New Era mine is equipped with a 10-stamp mill. The New York-Searchlight Mines Company installed a new hoisting and pumping plant. The Searchlight Copper-Gold Mining Company continued tunnel work. Developments on the property of the Santa Fe Mining Company include a 245-foot incline shaft and 2,000 feet of drifts and laterals. A number of other companies, which have done considerable development work in the past, reported only assessment work in 1908.

Yellowpine district.—Eleven producing mines in this district shipped 2,627 tons of crude ore to the smelters, carrying $92 in gold and $5,326 in silver values, in addition to 42,144 pounds of copper, 720,285 pounds of lead, and 1,115,851 pounds of zinc. The re-treatment of tailings in this district added $7,699 in gold and $105 in silver, making the total value of the mineral product of the district $101,482 for the year. The zinc-carbonate ores of this section were the source of the entire zinc output of the State during 1908.

Lead ores carrying silver values were shipped to Salt Lake smelters from the May group and from the May Consolidated mines.

During development work the Ninety-Nine Copper Company shipped some copper ore. This property is opened by a vertical shaft 175 feet deep and a tunnel approximately 1,000 feet long.

Harney Hardy & Co. reported a shipment of precious metal bearing copper ore from the Pilgrim mine. The Yellowpine Mining Company, operating the Rover group, shipped crude lead ore to Salt Lake smelters and zinc ore to Kansas smelters, but made no effort to market the mixed lead-zinc ores or low-grade ores.

At the Monte Cristo mines high-grade zinc-carbonate ores were quarried from open pits and shipped crude to smelters at Gas, Kans., during November and December of 1908. A shipment of high-grade lead ore was extracted in doing the annual work on the Murphy mine. The Potosi Zinc Lead Mining Company, while developing the upper levels of the mine, made shipments of zinc ore for three months only to the smelters at Gas, Kans. Operations by the Nevada-Keystone Mining Company were confined to the re-treatment of old tailings during 1908. Shipments of lead ores carrying some silver values were made from the Tam O'Shanter mine and from the Shenandoah mine, and the operators of the Fifty-six mine made a shipment of copper ore.

Among the developing operators were the Mobile Mining Company, the Kansas-Nevada Mining Company, the Nevada Copper Company, and the Lucky Strike Mining Company.

DOUGLAS COUNTY.

In Douglas County in 1908, 3 placer mines and 2 lode mines made a production of 161.81 fine ounces of gold, valued at $3,345, and 32 fine ounces of silver, valued at $17, or a total precious metal output of $3,362. This is almost double the total value of the metallic production of 1907, which included a small copper product. In 1908 the lode-mine output was derived from the Gardnerville section, and the Genoa district was the source of the placer production.

Buckskin district.—There was no production in the Buckskin district in 1908.

Gardnerville district.—In this district, which includes the Red Canyon section, a short test mill run was made by the Pinenut Mines Development and Power Company in its 5-stamp mill. The company reported the occurrence of quicksilver in the ore mined in 1908. The operators of the Orpheus mine made bullion shipments during the year. At the Aetna mine, in the Red Canyon section, a considerable tonnage of copper ore was placed on the dump. At the Longfellow mine considerable development work was in progress. A total of 3,000 feet of development work was reported, consisting of shafts ranging from 50 to 125 feet deep and tunnels ranging from 100 to 500 feet long. A light 7-stamp concentration and pan-amalgamation mill is used for test purposes. The Success Mining Company did not operate its placers.

Wellington section.—Some activity was noted in the portion of Douglas County just west of and across the county from Wellington, where copper ores have been found. The Poco Tempo Mining Company was operating in the Silver Glance Mining district. The property is equipped with a 5-stamp mill.

ELKO COUNTY.

Mine production of metals and their ores in Elko County, Nev., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	7,046.79	$145,670	8,921.27	$184,419	+1,874.48	+$38,749
Silver.....do....	34,464	22,746	47,480	25,164	+ 13,016	+ 2,418
Copper.....pounds..	164,592	32,918	130,197	17,186	− 34,395	− 15,732
Lead.....do....	137,795	7,303	478,881	20,113	+ 341,086	+ 12,810
Zinc.....do....	38,735	2,285	.....	.....	− 38,735	− 2,285
Total value.....	.....	210,922	.....	246,882	.....	+ 35,960
Ore output.....short tons..	42,531	[a] 4.96	26,438	[a] 9.30	− 16,093	+ [a] 4.34

[a] Value per ton, placer product excluded.

The total value of the metallic output of Elko County was $246,882, a gain of $35,960 as compared with the returns for 1907. Nearly three-fourths of this total, or $184,419, was in gold, which was an increase of $38,749 over the gold production of 1907, and was largely accounted for in the production from Gold Circle. The silver product made a proportionate gain of 47,480 fine ounces, valued at $25,164. The lead product showed a great increase to a total of 478,881 pounds, valued at $20,113. This gain, as well as the increased silver product, was largely due to greater activity in the Tecoma district. A slightly decreased quantity of copper was shipped. No zinc output was reported for 1908.

There were 26,438 tons of ore treated in 1908, or 16,093 tons less than in 1907; but in 1907 there were milled 13,215 tons more of old tailings, which were low in value and reduced the average value per ton.

In 1908 there were 20,167 tons of crude ore milled in Elko County, yielding $149,689 in gold and $2,849 in silver, an average value of $7.56 per ton in precious metals recovered as bullion. Of crude ore

1,771 tons were shipped to the smelters, which yielded $12,855 in gold and $15,959 in silver, in addition to the copper and lead values. This was an average of $16.27 per ton recovered in precious metals or $37.33 per ton in all metals. There were 32 mines reporting production in Elko County in 1908, including 3 placers. Of the 29 deep mines, classed by their chief products, there were 11 gold, 3 silver, 2 copper, 3 lead, 3 gold and silver, and 4 silver-lead mines.

During the year 1908 the mines of Aura district produced $3,39[illegible] in gold and $6,285 in silver from 246 tons of ore, approximately three-fourths of which was milled. The operators of the Jack Pot mine made a test mill run during 1908 in addition to shipments to the smelter on ore extracted mainly in doing development work. A small shipment of rich silver ore carrying small gold values was sent to the smelter from the Big Four mine. Gold values predominate at the Aura King mine, which is equipped with a 5-stamp mill. From the Astor group and the Blind Creole and the Diana mines development work was reported. The Denver Nevada Consolidated Gold Mining Company was constructing a ditch to its placer holdings. Development work was done on the Double Eagle group and on the Bull Run, Maggie, Weston, and Virgo mines.

Charleston section.—Development work was reported from 2 mines near Charleston, approximately 20 miles east of Mountain City. The claims of the New York-Nevada Mining Company are opened by a 1,500-foot tunnel, and the Black Warrior mine is developed by a 600-foot tunnel and a vertical shaft 120 feet deep. The surface equipment of the latter includes a 5-stamp amalgamation mill run by water power.

Carlin section.—A number of small outputs were reported from the mines in the region about Carlin, aggregating $1,554 in total value, of which more than half was won from placers. A few shipments were made from the Big Six mine, on which 2 incline shafts have been sunk.

Contact district.—A shipment of copper ore carrying silver was made during 1908 from the Hanks copper mine, which is opened by a 160-foot incline shaft. No shipments were reported by the Salmon River Mining Company.

Dolly Varden district.—Shipments were reported from 2 mines in the Dolly Varden district in the southeastern corner of Elko County. The operators of the Victoria mine, the principal producer, shipped only the higher grade of copper ore. The Dolly Varden Copper Company did not operate in 1908. Silver-lead ores carrying some copper was shipped from the Austin mine to the smelters.

Centennial and Vandusen districts.—Reduced returns were reported from these sections. In the Centennial or Edgemont district the Montana Mining Company, operating the Lucky Girl group, made the largest production of any mine in the county. The property is equipped with a 20-stamp amalgamation mill, with Frue vanners and cyanide and slimes treatment plants. This mine has been in operation for approximately ten years. Development work was done on the Midas mine.

In the Vandusen or Mountain City district the Protection mine is developed by an 800-foot tunnel and is equipped with a 10-stamp plate-amalgamation mill with 2 concentrating tables. A 1,360-foot tunnel opens the Nelson mine to a depth of 550 feet.

Gold Circle district.—In 1908 the new Gold Circle district became a factor in the gold output of Elko County. From 245 tons of ore from 6 mines $36,561 in gold and $621 in silver values were extracted. The average value per ton of ore sent to smelters was about $160. Only the best ore was shipped owing to the cost of wagon haul to the railroad, the lower grades being reserved for treatment at local mills which were being erected during 1908. Considerable development work was done in the district during the year by lessees, who opened bodies of milling ore reported to average from $8 to $30 per ton. Company work was confined to two or three properties. The Esmeralda mine was developed by lessees by means of a 500-foot tunnel and a 300-foot shaft. Developments at the Gold Circle Crown mine include a vertical shaft 240 feet deep and 2 tunnels, respectively, 560 and 440 feet long. At the Queen mine a portion of the ore was sent to the smelter and some crushed ore was handled in a crude rocker. The ore was extracted through a short tunnel. Development work on the holdings of the Rex Mines Company includes a vertical working shaft 100 feet deep and 1,075 feet of drifts and crosscuts. The Gold Circle-St. Paul Mining Company reported one smelter shipment and 500 feet of development work. The Gold Circle-Elko Prince Mining Company extracted some ore, but stored it until the custom mill should be completed.

Railroad district.—From the Railroad or Bullion district, southeast of Palisade, 4 mines shipped to smelters 649 tons of ore containing metallic values as follows: Gold, $965; silver, $5,309; copper, $8,887; and lead, $3,137—a total of $18,298, and an average value in all metals of $28.19 per ton.

The Nevada Bunker Hill Mining Company made a shipment of slag from their old smelter dump in addition to the regular production of silver-lead ore carrying copper and zinc. Only about a third of the ore extracted was sent to smelters. The mine is developed by a 600-foot vertical shaft and approximately 2 miles of tunnels on 5 different levels. The Sweepstakes mine, which is developed by tunnels, was operated during the year by the Delmas Copper Company. Individual operators also sent out small test shipments from this section during the year.

Ruby Valley district.—Ruby Valley is in the south-central part of the county, on the east slope of the Ruby Mountains. The National Development Company, operating the Friday mine, made a few shipments of lead ore to the Utah smelters.

Spruce Mountain district.—The Spruce Mountain Copper Mining Company was the sole producer of this district during 1908. The Black Forest Mining and Smelting Company extracted silver-lead ore in 1908, but it was stored to be smelted in the company's 30-ton lead blast furnace during 1909. Development work comprised a tunnel 1,100 feet long and about 6,000 feet of other workings. Neither the Keystone nor the Monarch mines produced in 1908.

Tecoma district.—The metallic product of this district increased over sixfold as compared with that of 1907. Shipments consisted of lead ores carrying some silver and small copper and gold values and were made from 3 mines. The Jackson group, located 10 miles northeast of Tecoma, was the largest producer and was operated the entire year; the underground developments are not extensive. The Argyle mine was operated part of the year. The ore is found at surface. A small shipment was reported from the Cleveland mine for 1908.

Tuscarora district.—A considerable tonnage of tailings were treated during August, September, and October, 1908, in the McKenzie 100-ton cyanide plant. The Tuscarora Nevada Mines Company did no work during 1908. The Hydraulic Mining and Milling Company did not begin to operate its placer mine until 1909.

ESMERALDA COUNTY.

Mine production of metals and their ores in Esmeralda County, Nev., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	412,813.72	$8,533,617	289,527.76	$5,985,070	−123,285.96	−$2,548,54
Silver.....do....	101,789	67,181	438,588	232,452	+ 336,799	+ 165,27
Copper.....pounds..	105,274	21,055	32,500	4,290	− 72,774	− 16,76
Lead.....do....	67,535	3,579	590,119	24,785	+ 522,584	+ 21,2(
Zinc.....do....	543	32	.....	.....	− 543	− 3
Total value.....	.....	8,625,464	.....	6,246,597	.....	− 2,378,86
Ore output.....short tons..	130,441	[a] 66.13	208,421	[a] 29.97	+ 77,980	− [a] 36.1

[a] Value per ton.

The total value of the metallic production of Esmeralda County in 1908 amounted to $6,246,597, or $2,378,867 less than in 1907 and $1,046,946 less than in 1906. This very large falling off was due to the decrease of $2,548,547 in value of gold output occasioned by reduced yield from the mines at Goldfield. Much more silver was mined in Esmeralda County in 1908 than in the previous year, and the total value of $232,452 was an increase of $165,271, due to the shipments from the new producing camps of Lucky Boy, Lone Mountain, Hornsilver, and Rawhide. The first three of these districts were silver-lead producers and were also chiefly responsible for the large increase in the lead output.

Esmeralda County continued to rank first among the counties of Nevada as a producer of gold, but in 1908 it was surpassed by Ny County in the total values won from all metals. Seventy-six mines operating in 22 districts in this county, mined 208,421 short tons of ore, of which 206,935 tons were siliceous, 96 tons were copper, and 1,390 were lead ores. The siliceous ores were the source of almost the entire gold product and of nearly 43 per cent of the silver output. The lead ores furnished only 181.31 fine ounces of gold, but 250,08 fine ounces of silver, or more than 57 per cent of the production of this metal, were won from this class of ore, which composed less than 7 per cent of the county's total tonnage. Copper ores yielded but small returns in gold and silver, and only a nominal output was reported from the placer mines of the county.

Bullion returns from 144,676 tons of ore sent to gold and silver mills showed production valued at $2,064,257 in gold and $18,830 in silver, a total of $2,083,087 for both metals, and an average recovery valued at $14.40 per ton. From this ore 307 tons of concentrates were produced, which carried $18,218 in gold and $1,404 in silver values, or an average value of $63.91 per ton in both metals. Thus the 144,676 tons of milling ore yielded, from bullion and concentrates, a total valued at $2,082,475 in gold and $20,234 in silver, or a total average value of $14.53 per ton.

There were also 61,110 tons of crude ore shipped to smelters from Esmeralda County in 1908, valued at $3,877,099 in gold and $211,775 in silver, containing in addition 32,500 pounds of copper, valued at $4,290, and 590,119 pounds of lead, valued at $24,785, or a total value in all metals of $4,117,949. The crude ore treated at smelters therefore averaged $63.44 per ton in gold, $3.47 per ton in silver, $66.91 per ton in gold and silver, and $67.39 per ton in all metals. The re-treatment of 2,635 tons of tailings gave an additional recovery of $24,313 in gold and $439 in silver.

Aurora district.—The production from Aurora district was approximately the same as in 1907, and the mine of the J. S. Cain Consolidated Gold Mining Company continued to be the only producer of any importance. All of the ore from this mine, except one small shipment, was treated in the company's 20-stamp mill in 1908. The Aurora Esmeralda Mining Company purchased all of the holdings of the California Exploration Company. The Del Monte Cyanide Company was idle throughout the year, and the property was sold to the owner of the Golden Fleece mine, at Fletcher, 5 miles northeast of Aurora. At the Summit group a tunnel was being driven to crosscut the ledge.

Bovard district.—See Rawhide district.

Buena Vista district.—A slightly increased production was reported from the Buena Vista or Oneota district, which is on the Carson and Colorado Railroad about 10 miles east of the California line. The year's shipments consisted of 109 tons of ore, carrying $973 in gold, $3,319 in silver, a small quantity of copper, and approximately 27,000 pounds of lead, with a total value for all metals of $5,523. Ore from the Brownie mine was shipped to the Sodaville mill, which is a 5-stamp plate-amalgamation plant. Development work at the Brownie mine was carried on during part of 1908. Increased shipments of silver-lead ore, carrying small gold and copper values, were made from the Indian Queen mine by the Phoenix Mining and Milling Company. The operators of the Nellie May mine, at Basalt, also shipped silver-lead ore to the smelters. The White Mountain Mining and Milling Company operated the Tip Top group throughout the year. Some high-grade ore was sacked for shipment, but the milling ore was placed on the dump. The mine is developed by about 900 feet of tunnels, drifts, and shafts.

Cuprite district.—See Hornsilver district.

The following table shows the production of metals and ores in the Goldfield district in 1908:

Mine production of metals and their ores in Goldfield district,[a] Nev., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	406,756.16	$8,408,396	236,082.14	$4,880,251	−170,674.02	−$3,528,145
Silver.....do....	71,710	47,329	30,823	16,336	− 40,887	− 30,993
Copper.....pounds..	.....	.....	1,606	212	+ 1,606	+ 212
Total value.....	.....	8,455,725	.....	4,896,799	.....	− 3,558,926
Ore output.....short tons..	101,136	[b] 83.61	88,152	[b] 55.55	− 12,984	− [b] 28.06

[a] For the geology and mining industry of Goldfield, see Ransome, F. L., The geology and ore-deposits of Goldfield, Nev.: Prof. Paper U. S. Geol. Survey No. 66, 1909.
[b] Value per ton.

The value of the gold production from the Goldfield district in 1908 was $4,880,251, which was less by $3,528,145, or 42 per cent, than that of 1907. Likewise the silver output of 30,823 fine ounces in 1908 was 40,887 ounces, or over 57 per cent smaller than in 1907. In 1908 a small copper product was mined in the district.

The total value of all metals produced in the district in 1908 was $4,896,799, a decrease of $3,558,926 in value as compared with that of 1907. This makes the district take second place to Tonopah in total value of all metals mined in 1908, but it still retains the lead as a gold producer by a wide margin.

Twenty-three mines in 1908 produced 88,152 tons of ore, with an average value of $55.55 per ton. All except two small shipments of copper ore would be classed as siliceous ore. There were $1,084,479 in gold and $2,810 in silver won from 30,003 tons of ore treated at gold and silver mills, an average recovery of $36.24 per ton. From this ore 298 tons of concentrates were produced, carrying $16,552 in gold and $99 in silver values, an average value of $55.87 per ton. Thus there was a total average recovery of $36.79 per ton from ores sent to mills. The 58,025 tons of crude ore shipped to smelters carried $3,775,195 in gold, $13,427 in silver, and $212 in copper values, an average value of $65.30 per ton. There was also a gold saving of $4,025 from the re-treatment of old tailings in the district during 1908. It will be seen that with the advent of milling operations on a moderate scale in the district the grade of ore treated at the mills dropped from $44.90 per ton in 1907 to $36.79 in 1908, and likewise along with diminished smelter shipments, the average value per ton of ore smelted fell from $91.86 per ton to $65.30 per ton. The following table furnishes a summary of these changes noted in methods of treatment of Goldfield ores:

Ore production in Goldfield district, in 1907 and 1908, classified according to method of treatment.

Year.	Ore to smelters.		Ore to mills.		Total.	
	Short tons.	Average value per ton.	Short tons.	Average value per ton.	Short tons.	Average value per ton.
1907	83,354	$91.86	17,782	$44.90	101,136	$83.61
1908	58,025	65.30	30,003	36.79	[a] 88,152	55.55
Increase (+) or decrease (−)	−25,329	−26.56	+12,221	−8.11	−12,984	−28.06

[a] Old tailings, 124 tons.

The following table shows production of gold and silver in the Goldfield district from the time it became productive up to the end of 1908:

Mine production of Goldfield district, Esmeralda County, Nev., from its inception in 1903 to 1908, inclusive, in fine ounces.

Year.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
1903	3,418.66	$70,670	287	$155	$70,825
1904	113,293.23	2,341,979	19,954	11,374	2,353,353
1905	91,087.76	1,882,951	8,589	5,188	1,888,139
1906	339,890.20	7,026,154	15,648	10,484	7,036,638
1907	406,756.16	8,408,396	71,710	47,329	8,455,725
1908	236,082.14	4,880,251	30,823	16,336	4,896,587
	1,190,528.15	24,610,401	147,011	90,866	24,701,267

During 1908 the tendency to return to company work in the operation of the mines of the district was more firmly established. But few new leases of importance were granted during the year, and as a rule only ground in the unproven or outlying districts was open to lessees.

The great Goldfield Consolidated mines are largely responsible for the decreased output of the district in 1908, as the total value of their output for that year was but little more than two-fifths as large as in 1907. This decrease resulted not from any falling off in available resources at their various mines, but in accordance with the company's plans as shown by the following quotation from the president's printed annual report for the year ending October 31, 1908:

"During the year the mines of your company have produced 32,755.82 tons, having an average gold value of $41.50 per ton; and 12,254 tons of second class ore, which was placed on reserve dump, carrying an average value of $7.76 per ton.

"The Combination 20-stamp mill treated 28,473.47 tons containing $1,145,157.76, or $40.218 per ton. Leasers operating on your property during the year produced 25,539.66 tons, containing $945,196.01, or $37.01 per ton; in all, 70,549.48 tons, of a gross value of $2,400,191.62. This production, relatively small when viewed in the light of the company's facilities, it will be borne in mind, was due to the fact that only the Combination mine and mill were in operation. Your board of directors deemed it advisable, owing to exorbitant freight and smelter charges, to suspend all shipments of ore and await the completion of the new mill. Consequently no attempt has been made in the direction of production beyond the capacity of the Combination mill, although development work of magnitude has been prosecuted."

The new 100-stamp amalgamation, concentration, and cyanide mill[a] was completed and put into operation December 26, 1908, and the company's mines began producing again.

About 38,000 feet (over 7.2 miles) of development work was done by the Goldfield Consolidated Mines Company in 1908. The company also built a standard gage railway about 2 miles in length, with branches to connect all the working shafts of the company with the new mill and with the railroads entering Goldfield. The main line was completed during April in time to be of service in transporting materials and equipment to the new mill. Reservoir facilities for the storage of 1,000,000 gallons of water were provided by means of 10 tanks.

The Florence Goldfield Mining Company was the largest producer of the district for the calendar year 1908, a substantial increase being reported as compared with the company's output in 1907. The entire tonnage from the holdings of the Florence Company was shipped to smelters during 1908, but during this period the company was erecting a 40-stamp amalgamation and concentrating mill and a cyanide plant.

The Goldfield Daisy Mining Company made increased shipments to smelters and sank the main shaft from the 200-foot to the 400-foot

[a] This mill was described in the mines report for Nevada for 1907 under title "Notes on the metallurgical treatment of Nevada gold and silver ores." Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, pp. 385-398.

level; drifts and crosscuts were driven on the 300-foot and 400-foot levels. The Goldfield Daisy, and the Quartzite and Black Butte mines, from which increased shipments were made, are located in the Diamondfield section of the district. The Combination Fraction Mining Company operated throughout the year. The mine is developed by a vertical shaft 612 feet deep.

The Jumbo Extension Mining Company has 2 shafts, one 300 and the other 600 feet deep. The production from this property in 1908 was mined by 2 leasing companies operating on the Gold Wedge claim during February and March; in July this claim was purchased by the Goldfield Consolidated Mines Company. The Goldfield Merger Mines Company was working the St. Ives and Velvet mines during the last half of 1908. The Butte Boys Consolidated Mining Company has a double compartment shaft 300 feet deep and 315 feet of crosscuts. There were several other small producers but none of any particular moment; in fact only 5 companies made a production of over $30,000 in the Goldfield district in 1908.

The Atlanta Mines Company has 19 shafts varying from 100 to 58[illegible] feet in depth. Forty per cent of this development work was done in 1908 by lessees. The Albemarle mine is opened by a 315-foot shaft. The Florence Extension Mining Company has a 650-foot shaft with 1,800 feet of laterals on 4 levels. The Gold Button Mining Company did 100 feet of shaft sinking toward the end of the year. The Goldfield-C. O. D. Company carried on development work through the shaft of the Gold Bar Mining Company. Lessees sank the shaft 200 feet and did several hundred feet of drifting for the Goldfield-Silver Pick Mining and Milling Company. The Desert Rose mine is developed by 2 shafts, respectively 300 and 150 feet deep and by 2,000 feet of levels. The Blue Bell Mining Company has a 380-foot shaft and the Booth Gold Mining Company has a 400-foot shaft and about 3,000 feet of other development work. Lessees were operating at both mines.

Gold Mountain district.—The Gold Mountain or Thorpe district lies in the extreme southern corner of Esmeralda County near the railroad station of Bonnie Claire which is in Nye County. Production was reported from 3 mines during 1908. The Bonnie Claire Mining and Milling Company did not operate the mine but shipped the concentrates produced in 1907. The mine is equipped with a 10-stamp mill and cyanide plant and is developed by a vertical shaft 800 feet deep and a tunnel 1,200 feet long. About 2,500 feet of development work, consisting of tunnels, drifts, winzes, and stopes have been done on the Nevada Empress mine, which was equipped with a Hathaway mill in the spring of 1909. The Richmond Gold Mountain Mining Company has about 750 feet of tunnels and crosscuts.

Hawthorne district.—A small bullion production, principally in gold, was reported from the Hawthorne district. The Esmeralda Consolidated Mining Company has a 300-foot shaft and is equipped with a 20-stamp mill. The Chloride group, at Buckley Camp, has a 550-foot tunnel, of which about 200 feet were driven in 1908. The Contact Gold Mining Company, on Alum Creek, and the owners of the Owl mine, the latter opened by a 400-foot incline shaft, continued development work. The Walker Lake Exploration and Development Company was absorbed by the Nevada Consolidated

Mines and Selling Company. The development work reported includes 1,068 feet of drifting and crosscutting.

Hornsilver district.—The Hornsilver district lies 26 miles south-southwest of Goldfield, 14 miles southwest of the railroad station of Cuprite, and 12 miles southeast of Lida. Prospecting was done in this district as far back as 1868. Its rocks are described as being "limestone and calcareous shales which have been intruded and in places more or less metamorphosed by masses of granite."[a]

During 1908, 586 tons of ore were mined in this district, from which $3,517 in gold and $38,625 in silver values were extracted, in addition to a small lead product.

The Great Western Gold Mining Company was the principal producer in 1908. The mine developments include a 300-foot shaft and about 1,000 feet of drifts. Shipments of silver-lead ore, carrying small values in gold, were made from the Redemption mine in 1908. From the Frances Limepoint, Sunspot, and Grand Central mines also ore was shipped during the year. The Marlview Mining Company was the only producer from the Cuprite section.

Klondike district.—Two carloads of silver-lead ores, carrying some gold, were shipped during 1908 from the Klondike district.

Lida district.—There was a small production from the Lida district in 1908, principally in gold and silver values. One shipment carried some copper and lead. The Goldfield Tunnel and Mining Company and the Lida Wisconsin Extension Mining Company were absorbed by the Calumet and Nevada Consolidated Mines Company. The development work, a good portion of which was done in 1908, includes tunnels, shafts, and drifts aggregating 1,000 feet. Development work was also done by the Ohio Lida Mining and Milling Company. The Lida Queen is an old mine, having been worked twenty-five years ago. It is opened by a 250-foot vertical shaft; the old workings were cleaned out and a 10-stamp mill and concentrating plant were erected. The Golden Silver Peak Mining Company has a 200-foot shaft. The Silver Crescent Quartz and Placer Mining Company was operating in the Tule Canyon section. The gravel is said to average about 15 feet in depth.

Lone Mountain district.—The Nevada Alpine Mining Company shipped considerable silver-lead ore, carrying small copper and gold values. The Quincy Mining Company also shipped silver-lead ore carrying small gold values. The mine is developed by tunnel, winze, and crosscuts aggregating 700 feet. This property has been operated for the last five years.

Lucky Boy district.—The new silver-lead camp of Lucky Boy lies 8 miles south of Hawthorne, on the old Bodie stage road, in secs. 18 and 19, T. 7 N., R. 30 E., Mount Diablo meridian, and at an altitude of about 7,000 feet, or approximately 2,600 feet higher than Hawthorne. The ores are reported to be principally argentiferous galena and occur in fissure veins in limestone and granitic rocks, with the best values occurring in the limestone. Because of the expensive wagon haul to the railroad station at Thorne, all of the ore is hand sorted. The shipping product was said to average from 25 to 30 per cent in lead and 150 to 200 ounces per ton in silver. Prospecting began in the fall of 1907, and the first shipments were made in March of 1908. The

[a] Ransome, F. L., The Hornsilver district, Nevada: Bull. U. S. Geol. Survey No. 380, pp. 41–43.

entire production for the year 1908 was mined from the Mountain King group, owned by the Goldfield Alamo Mining and Leasing Company. This property is opened by a 300-foot incline shaft and tunnels and drifts aggregating 1,500 feet.

Mina, Sodaville, and Santa Fe districts.—The Marietta Mines Company made a small production during 1908 from their property near Mina.

In the Sodaville section operators of 3 small mines shipped lead and gold ore to smelters during 1908.

In the Santa Fe district (including the mines at Acme City, at Luning, and north of Mina) 8 mines produced 2,143 tons of ore, bearing the following metal values: Gold, $14,741; silver, $1,644; copper, $3,212 and lead, $808—a total of $20,405.

The Arizona-Nevada Mining and Milling Company has 3 groups of claims at Luning on which considerable development work has been done. A carload of copper ore carrying gold values was sent to the smelter.

The Blue Light Copper Mining Company also made a trial shipment of precious metal-bearing copper ores and did considerable development work in 1908. The main shaft is 722 feet deep. Only assessment work was done at the Hardscrabble mine, but a considerable tonnage of tailings was treated in the 60-ton cyanide plant. The Nevada Lead mines, Del Monte Goldfield Mining Company, and Luning Consolidated Mining Company were also active during the year. The Luning Gold Mines Syndicate reported development work, including 200 feet of shaft sinking and 400 feet of tunnel driving.

Montezuma district.—A few small shipments were sent to the smelters from the Montezuma district, which lies about 7 miles due west of Goldfield. Most of the ore would be classed as lead ore with precious metal values predominating.

Palmetto district.—Palmetto lies about 12 miles west of Lida and within 4 or 5 miles of the California State line. A number of small shipments of lead ore bearing good precious metal values were made during 1908, but most of the mines were idle throughout the year.

Pine Grove district.—The total value of the precious metal production from this district was a little less than in 1907. The Wheeler Gold Mines Company, the principal producer in this section, is located on the east Walker River, 30 miles southeast of Yerington. The mine is equipped with a 5-stamp amalgamation and concentrating mill, and the development work, about one-half of which was done in 1908, includes 300 feet of incline shafts, about 2,000 feet of tunnels, and 300 feet of raises. The mine was worked continuously throughout the year. The Mountain View mine is included in this district for want of a more exact location. Ore from this mine was shipped to the mills at Silver City. The mine is developed by 3 tunnels aggregating 1,100 feet in length, and 2 shafts, the deepest 250 feet in depth. The Crabb mine is opened by a tunnel 300 feet long. The properties of the Nevada Rockland Mining and Milling Company were idle during 1908 and were taken over by the Rockland Syndicate.

Rawhide district.—Nine mining companies made a total production in 1908 of 1,826 tons of ore, which yielded $125,475 in gold and $21,714 in silver, or a total value of $147,189. The average value per ton was $80.61. Of this output 973 tons were treated in gold and silver mills, with a bullion recovery of $36,466, of which $31,610 was in gold and

$4,856 was in silver values, a total average recovery of $37.48 per ton from mill ore. This ore was handled by local mills and by the Davis mill at Dayton. The 853 tons of ore sent to smelters carried $93,865 in gold and $16,858 in silver values—a total of $110,723, and an average yield of $129.80 to the ton. As the cost of hauling the ore to the railroad at Fallon was $7 per ton and as the freight and treatment charges ranged from $20 to $33 per ton, according to the grade of the ore, it was profitable to send only the higher grades to the smelters and await the completion of the mills to handle the rest of the ore. The mining boom at Rawhide started early in 1908, and the first substantial shipments were made in April, only small test lots being sent out earlier.

In the face of the money stringency development work progressed throughout the year. Very little company work was undertaken, as leasing companies did most of the mining in 1908.

The Rawhide Coalition Mines Company has 8 claims and 3 fractions, or a total of 174 acres in the heart of the district. Operations began in November, 1907, and were carried on continuously throughout 1908 by about 25 leasing companies on different blocks of ore. The engineer's report to the company as to the number of feet of work done on the company's holdings up to May 1, 1909, listed 4,984 feet of shafts, 4,147 feet of crosscuts, 2,757 feet of drifts, 775 feet of tunnels, and 413 feet of winzes—a total of 13,176 feet. Twenty-five hoists were working at that time. The more important producers among these leasing companies include the Grutt Hill Mint Mining Company, operating the "Mint lease," the Nevada Rawhide Gold Mining Company, working the "Miller lease," and the Truet lease on Hooligan Hill. The Royal Tiger Mining Company has been developing since March 1, 1908, and all shipments have resulted from shaft sinking and drifting, as no stoping was done. The main incline shaft is 450 feet deep. A large production was also made from the holdings of the Rawhide Queen Mines Company, principally by the Kearns No. 2 Mining and Leasing Company, which reported development work consisting of a vertical shaft 400 feet deep and about 1,000 feet of drifts. There were several lessees shipping from the Rawhide Rector Mines Company's property. The Regent Syndicate mines sent some ore to local mills. Five sets of lessees were operating on the Bethania mines. One small shipment resulted from prospect work on the Rawhide Wonder King Combination claims.

Bovard section.—This district is just south of Rawhide district, and almost a part of it, but the figures of production are not included in the totals for Rawhide given above. The Bovard Strike Gold Mining Company, operating the Golden Pen mine, made the only production from this section. This mine is opened by a vertical shaft 130 feet deep and a short tunnel. The ore was milled at Rawhide.

Schurz section.—The Beach copper mine near Schurz was developed by shaft and tunnel. Ore has been stored on the dump.

Sweetwater district.—One small shipment of high-grade silver ore was made from this district in 1908. Development work was carried on throughout the year at the Tananak gold mine, which is opened by a 1,500-foot tunnel and is equipped with an 8-stamp amalgamation mill run by water power.

Silver Peak district.—The production from Silver Peak district in 1908 represents the consummation of several years of mine development and mill building and places the district second only to Goldfield as a source of gold in Esmeralda County.

The Pittsburg Silver Peak Gold Mining Company's holdings, which include those of the Mohawk Alpine Mining Company, are developed by tunnels varying from 600 to 6,000 feet in length. The surface equipment includes a 100-stamp amalgamation mill and a cyanide plant which was completed in March, 1908. In the mill 60 stamps were dropping for four months and 100 stamps the remainder of the time. The Silver Peak Valcalda mine also contributed a substantial production to the output of this district in 1908. The surface equipment includes a 10-stamp amalgamation mill with a 30-ton cyanide plant, using a tube mill, filter presses, and agitators. The reduction works were run until the end of October after which only underground development was carried on. About 600 feet of drifting was done in 1908.

Silver Star district.—A shipment of lead ore, carrying precious metals and a little copper, was reported from the Silver Star district, west of Tonopah Junction and north from Belleville.

EUREKA COUNTY.

Mine production of metals and their ores in Eureka County, Nev., in 1907 and 1908.

Metal.	1907.		1908.		Decrease (—).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	8,424.36	$174,147	8,339.66	$172,396	— 84.70	— $1,751
Silver.....do....	252,889	166,907	140,551	74,492	—112,338	— 92,415
Copper.....pounds..	144,825	28,965	79,985	10,558	— 64,840	— 18,407
Lead.....do....	2,992,117	158,582	2,330,048	97,862	—662,069	— 60,720
Zinc.....do....	3,075	181	.....	.....	— 3,075	— 181
Total value.....	.....	528,782	.....	355,308	.....	—173,474
Ore output.....short tons..	36,358	[a] 14.54	28,198	[a] 12.60	— 8,160	— [a] 1.94

[a] Value per ton.

The total value of the metal production from Eureka County was $355,308, being but two-thirds as large as in 1907. In 1908 decreases were made in the quantity and value of each metal, as well as in the number of tons mined and in the average value per ton. Twenty-two deep mines (11 more than in 1907) produced 1,474 tons of siliceous ore and 26,724 tons of lead ores in 1908.

The siliceous ore, which constituted but a little over 5 per cent of the total ore mined in the county, yielded 2,416.38 fine ounces of gold, valued at $49,951, and 19,572 fine ounces of silver, valued at $10,373, or nearly 29 per cent of the gold and 14 per cent of the silver product.

The lead ores, forming nearly 95 per cent of the total tonnage, were the source of 5,923.28 fine ounces of gold, valued at $122,445, and of 120,979 fine ounces of silver, valued at $64,119, or more than 71 per cent of the gold and over 86 per cent of the silver output.

During 1908 almost the entire tonnage of Eureka County was shipped out to smelters. The production from one mine was handled by a gold and silver mill and that from another mine was concentrated.

The smelting ore averaged $6.21 per ton in gold, $2.66 per ton in silver, and $12.34 per ton in all four metals. In 1908 Eureka County retained its rank as the largest producer of lead among the counties of Nevada, with an output of 2,330,048 pounds, or over 32 per cent of the total production of the State.

Eureka district.—Nearly the entire metallic output of the county was mined in this district, and a major portion of the production was extracted from the old Richmond and Eureka Consolidated mines by the United States Smelting Company. The ore was shipped to the company's smelting plant at Salt Lake City and most of it carried gold, silver, lead, and copper, averaging about $10 per ton in total value. It was desirable chiefly for its fluxing qualities. The Windfall mine was the second largest producer of the district. During 1908 the ore was sorted and shipments carrying rather high gold and silver values were sent to the smelter. The Eureka Windfall Mining Company, the present owner, is erecting a cyanide mill in 1909 to treat the lower grades of ore. The mine is opened by an incline shaft 130 feet deep. The Standard mine, operated by the Adams Hill Mining Company, is developed by a 270-foot vertical shaft. A shipment of gold-silver-lead ore was made from the Beehive mine in the Prospect section during the year. The Bullwhacker Mining Company shipped lead ore carrying silver and gold during part of the year. Shipments from the Auro Cyanide mine carried gold, silver, and lead. The values in the ore shipped by the Diamond Mining Company were about equally divided between gold, silver, and lead, while in that from the Excelsior Mining Company the gold values equaled the combined silver and lead values. The Fish Creek Wells mine was operated part of the year. There are an inclined shaft 420 feet deep and a 300-foot tunnel on the Laurel and Hidden Jewel mines. Lessees were working the Phoenix mine throughout the year by means of a vertical shaft 500 feet deep, and lessees also mined some ore from near the surface on the Ruby Pioneer group. The Nevada Developing and Mining Company was developing its Holly mine, which has a 400-foot vertical shaft, 200 feet of which were sunk in 1908.

Cortez district.—No shipments were reported from the Cortez district. Development work was done at the Flagstaff-Cumberland-Silver Cloud group. The Tenabo Mining and Milling Company has 2 main tunnels on the Garrison mine, one being 5,200 feet long and the other 4,580 feet long.

Palisade district.—The Zenoli Silver Copper Company made reduced shipments from this section. The property, which is located 6 miles west of Palisade, is operated by means of a 480-foot tunnel. The Pearl mine was developed, and likewise the Palisade-Pittsburg mines.

Maggie Creek section.—The Nevada Star Mining Company has been carrying on development work since 1906 at its property on Maggie creek, north of Palisade and northwest of Carlin. The mine was opened by an incline shaft 264 feet deep.

Mineral Hill district.—The 1900 and Hecla mines were sold to the Mineral Hill Consolidated Mines Company, but no mining was done in the district during 1908.

HUMBOLDT COUNTY.

Mine production of metals and their ores in Humboldt County, Nev., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	2,983.00	$61,664	13,217.36	$273,227	+10,234.36	+$211,563
Silver.....do....	31,488	20,782	39,552	20,963	+ 8,064	+ 181
Copper.....pounds..	118,793	23,759	54,598	7,207	− 64,195	− 16,552
Lead.....do....	58,880	3,121	38,024	1,597	− 20,856	− 1,524
Zinc.....do....	19,046	1,124	.....	.....	− 19,046	− 1,124
Total value.....	.....	110,450	.....	302,994	.....	+ 192,544
Ore output .....short tons..	8,638	[a] 12.79	11,507	[a] 26.30	+ 2,869	+ [a] 13.51

[a] Value per ton, placer product excluded.

The total value of the production of metals from Humboldt County in 1908 was $302,994, or nearly two and three-fourths times as much as in 1907. Nine-tenths of this total, or $273,227, was the value of the gold product, which was almost four and one-half times as large as it was in 1907. The increase of $211,563 in the gold output and the gain of 8,064 fine ounces in the quantity of silver produced is due to the substantially increased production from the Chafey and Seven Troughs districts. The copper total of 54,598 pounds is but a little more than half the production of 1907 and results from reduced shipments from the Humboldt district and from the Adelaide district, near Golconda.

There were 30 producing lode mines in Humboldt County in 1908, including 19 gold, 8 silver, 1 gold and silver, 1 copper, and 1 silver-lead mine. Of the 11,507 tons of ore mined, 7,845 tons were siliceous ore, 3,575 tons were copper ores, and 87 tons were lead ores. The latter two classes were from the mines about Golconda, as the ores from the mines of the other districts were all siliceous. Of the county's gold production 13,192.69 fine ounces, or over 99.8 per cent, was won from siliceous ore, the combined yield from copper ores, lead ores, and placer mines being only 24.67 fine ounces. The siliceous ores also supplied 35,128 fine ounces, or 89 per cent of the silver production, but the base-metal ores furnished a larger percentage of the silver than of the gold totals. The increase in the total average value per ton of the Humboldt County ores from $12.79 in 1907 to $26.30 in 1908 was brought about by the greatly increased yield of high-grade ore from the Seven Troughs district, which furnished nearly one-third of the total tonnage, two-thirds of the gold output, almost one-half of the silver production, and more than three-fifths of the total value of all metals in 1908.

Gold and silver mills treated 6,086 tons of ore in Humboldt County, with a bullion yield of $183,056, or an average of $30.08 per ton in precious metals, of which the gold recovery was $178,077, or $29.26 to the ton, and the silver saving was $4,979, or 82 cents to the ton. From this ore 21 tons of concentrates were produced, which carried $3,147 in gold and $203 in silver, or an average of $159.52 per ton in both metals. Thus the total recovery from the 6,086 tons of crude ore sent to the gold and silver mills was $30.63 to the ton.

The bulk of the copper ores of the county were sent to concentrating mills. The 1,839 tons of ore shipped to smelters contained $91,552, or an average of $49.78 per ton, in gold, and $15,140, or an average of $8.23 per ton, in silver, a total of $106,692 in precious-metal values, and an average of $58.01 per ton. Including the base metals, the crude ore sent to smelters during 1908 was valued at $108,358, or $58.92 per ton.

Ashdown district.—After a year spent in development work the operators of the Pine Forest mines began milling gold ore again in 1908 in their 5-foot Huntington plate-amalgamation mill. These mines are developed by 6 tunnels which aggregate nearly a mile of workings. The Ashdown Mining Company was also active, but the properties of the Nevada King Mining Company and the Vicksburg Denio Mining Company were idle.

Chafey district.—This new district lies east of Mill City and near Dun Glen. The Mayflower mine made a very substantial production during 1908. Half of the ore was shipped to the smelters and the remainder was treated in the company's own mill, in which the ore is fed to a 3-stamp Merrill mill, reground in two 6-foot Huntington mills, and then passed over amalgamating plates and Wilfley tables. The mine is opened by tunnel and shaft, the workings aggregating 800 feet. Small shipments were made from two other properties in this district during the year.

Fitting district.—This district lies approximately 20 miles northeast of Lovelocks. There was a large decrease in the output from the district as compared with that of 1907. The Bonanza King mine, the sole producer in 1908, was operated for a short time under lease. The property is equipped with a 15-stamp amalgamation and concentration mill and is opened by a 300-foot vertical shaft. The Bonanza King Mining Company has been reorganized as the Humboldt King Mining Company. Only the assessment work was done on the Humboldt Queen mine.

Goldbanks district.—No production was reported from this district. The New Mohawk group was being developed and has been opened by 7 incline shafts ranging up to 150 feet in depth. Development work was also done on the Flusey-Quartette group.

Golconda section (Adelaide and Gold Run districts).—The Adelaide mine was not worked during the year, but the Glasgow and Western Exploration Company (Limited) ran its 120-ton concentrating mill at Golconda for six months on ore mined previous to 1908 and shipped less concentrates than in 1907. Since the copper values predominate, the total value of the product was only about two-fifths as large as in 1907 because of the decreased price of this metal.

The Gold Run district made an increased production, operators of 3 mines reporting ore shipments during 1908. The Nevada Central Mining Company, the only producer of the district in 1907, doubled its output of silver-lead ore, carrying small values of gold. The Golconda Gold Ledge Mining Company shipped some gold ore to the smelters from its Gold Ledge mine, which was worked continuously during the year. The development work includes a vertical shaft 220 feet deep and 1,284 feet of levels. The Leadville mine was operated for six weeks in 1908 and a shipment was sent to the smelters. About 1,000 feet of development work was continued at the Black

Diamond mine. The Nevada Crown Mining Company was also developing.

Humboldt district.—The mines about Humboldt House made a greatly reduced yield in 1908. The Imlay Mining Company was active during the entire year and shipped some crude ore to smelters and to concentrating mills. The mine is opened by a vertical shaft 250 feet deep. The Nevada Superior Mines Company's main developments include a 300-foot shaft and a 1,400-foot tunnel. This company also operates the adjoining property of the Antelope Spring Mining Company.

Kennedy district.—There was no change reported in the conditions in the Kennedy district and most of the properties limited their operations to doing assessment work.

Lovelocks district.—A small shipment of rich silver ore was made from the Silver Tip mine, near Lovelocks. The deposit was discovered in May, 1908.

Mill City or Central district.—The Central district, which lies about 10 miles northeast of Mill City in the Eugene Mountains, made only a small bullion production in 1908. The Sheba Gold and Silver Mining Company made a substantial output from this section in 1907, but their mines were idle in 1908.

National district.—The new camp of National lies approximately 60 miles due north of Winnemucca and about 12 miles south of the Oregon State line, on Twelve Mile Creek, a tributary to the Quinn River. Operations began late in 1908 and rich, free gold ore was found in the Nevada National property. It is reported that a little over 1 ton of ore netted the operators $63,000. The values are in gold and silver, which occur in about equal parts by weight.

Paradise Valley.—Only assessment work was reported by the operators of this section. Development work on the Wild Goose and Rough and Ready groups included a vertical shaft 600 feet deep and a tunnel 1,800 feet long; the Bullion mine is opened by a 400-foot vertical shaft and an 800-foot tunnel.

Rosebud district.—A production valued at $874 in gold and $2,665 in silver, a total of $3,539, resulted from small shipments from 3 mines in this district in 1908. The values in the ore shipped from the Brown Palace mine by the Nevada Rosebud Mining Company averaged over $2.66 in silver to $1 in gold; the values from the Durango Girl mine are almost wholly in silver. The Dreamland mine was leased. At the Cottontail group some ore was placed on the dump during development work, which includes a 100-foot vertical shaft and a 250-foot tunnel. Only assessment work was done on several other properties.

Rebel Creek.—Some development and prospecting work was done at the Nevada-Rebel-Creek mine and at the Midas mine.

Seven Troughs district.—In 1908, 10 mines produced 3,582 tons of siliceous ore, which yielded $180,501 in gold, $9,795 in silver, and small values in copper and lead, or an average value of $53.14 per ton. Of this total 3,480 tons were treated in gold and silver mills, resulting in a bullion product valued at $160,947, an average value of $46.25 to the ton. The gold yield of $156,275 represented an average recovery of $44.91, and the silver production of $4,672 was an average of $1.34 per ton. One small shipment of concentrates averaged in value over $190 in gold and $5 in silver. The smelter

shipments from the district consisted of 102 tons of ore, valued at $22,485 in gold and $5,076 in silver, in addition to the small values in copper and lead—a total average value in all metals of $270.82 per ton. The average value in gold was $220.44 per ton and in silver $49.76 per ton.

The Mazuma Hills Mining Company was the largest producer of the district. This concern holds 4 claims at Seven Troughs, on which 10 leases were operated during 1908. The company's 10-stamp amalgamation and concentration mill is at Mazuma. According to the printed annual report, the mine production was 2,474 tons of ore, which netted the company $114,092. Of this production 73 tons were shipped to smelters, netting $19,398, and 2,401 tons were milled, resulting in a bullion recovery of $92,894. The concentrates were not shipped during the year. The tailings are being carefully impounded for future treatment, as they are estimated to average in value $7 per ton. The mine developments include 1,773 feet of shafts, 1,625 feet of raises and winzes, and 4,541 feet of crosscuts and drifts, or a total of 7,939 feet of work. The Wihuja Gold Mines Company, operating on the Seven Troughs Therian Gold Mining Company's property, began sending ore to the Kindergarden mill in 1908. During the year the mine was opened by a 375-foot incline shaft and 280 feet of drifts. The Seven Troughs Golden Treasure Mining Company made one small test shipment to the smelter, and developed the property. The Seven Troughs Mining Company, operating the Fairview property, made the second largest output from the district. The mine is opened by a vertical shaft 750 feet deep. The Seven Troughs Kindergarden Mining Company also added to the production after completing their 10-stamp amalgamation and concentration mill. The mine developments include a 225-foot incline shaft and a 2-compartment vertical shaft, 320 feet deep. The Seven Troughs Eclipse Mining Company, the Ibex Mining Company, the Seven Troughs Buckhorn Mining Company, and the Seven Troughs Fine Gold Mining Company were all active in 1908.

Development work was done on the Bruno group, the Gold Crown claim, the Seven Troughs Cæsar group, the Seven Troughs Royal mine, the Silver-Lead group, and the Wild Cat and Little Hero mines; also on the properties of the Seven Troughs Gold Coin Mining Company and of Crumpacker & Sims. Several other operators reported some development work for the year.

Unionville (Buena Vista district).—At the Arizona and Wheeler mines, a small quantity of ore was treated in a 2-stamp amalgamating and concentrating mill. A small lot of custom ore was also reduced in this mill. The mines are developed by tunnels, ranging from 500 to 1,000 feet in length. Little work was done on the Alma and Aduna and the Clipper groups, which are opened by a 1,000-foot tunnel.

Winnemucca district.—There was but little activity in this section. The Inter Mountain Metal Mining Company was installing a heavy pumping and hoisting plant. Prospecting work was done on the Lane and Bryan group in Boyd Basin.

LANDER COUNTY.

In Lander County the figures of 1908 show a materially reduced yield from those of 1907 in gold, silver, copper, and lead. The total

yield of the county in 1908 was valued at $46,843 for all metals. There were 1,998 tons of ore worked in 1908 from the districts of Reese River or Austin, Battle Mountain, Copper Basin, Galena, Cortez, Lander, and Dean.

Austin district.—This old district, long known as Reese River, made a total production valued at $10,119 in 1908, of which $8,455 was in silver. None of the mines were large producers. The mines of the Austin Manhattan Mining Company were operated under lease. The 20-stamp mill and reduction plant was undergoing a remodeling process. The Austin Goldfield Mining Company was operating, and shipped screenings from the dumps. From the Lemaire group one carload of ore was shipped. Among other producers were the Double H, Gault, Gold Park Mining Company, Laurent, McCourt & Effrich, M. E. Leasing Company, and Murray.

Battle Mountain district.—The total output of this district was valued at $5,189, from 94 tons of ore derived from the Marysville, Lucky Strike, and Golden Era mines. The ore from the Marysville was taken from the Aztec and Monte Cristo mines.

Copper Basin and Galena districts.—Southwest of Battle Mountain lie the Copper Basin and Galena districts which in 1908 yielded a production valued at $9,212 from 338 tons of ore. The producers in the districts are the Giant (Copper Basin group), El Dorado Mining Company, and Iron Mines group. The main values in the ore are in silver and lead.

Cortez district.—In this district the principal producer is the Cortez Metal Recovery Company, whose 100-ton cyanide plant was constructed during 1908. The old leaching mill was cleaned out and the cyanide plant started on tailings in October. The mines of the Keystone Mining Company at the same place were small producers. A number of other properties are waiting for the erection of a custom mill.

Lander district.—The total output of Lander district in 1908 was valued at $9,211, mainly in silver and gold with a little copper and lead. The largest producer was the Lander Mill and Mining Company; the property was worked only during three months in 1908. The Lovie Mining and Milling Company, the Stanley, Mason, Silver Sides, Hale & May mines, and the Fort Hill Mining Company were the other producers.

LINCOLN COUNTY.

A number of mining districts which were formerly in Lincoln County are now included in the new Clark County, so that the districts to be considered in Lincoln now are the Caliente, Eagle Valley, Ferguson, Pioche, and Stateline. The production of Lincoln County in 1908 was valued at $724,242. No proper comparison can be made of the output in 1908 with that of 1907, because of the division of the county. The product mentioned included 25,073.05 fine ounces of gold, valued at $518,306; 232,615 ounces of silver, valued at $123,286; 277,727 pounds of copper, valued at $36,660; and 1,095,000 pounds of lead, valued at $45,990. There are no productive placers in the county, and the deep mines producing number 14. These deep mines produced 134,180 tons of siliceous ore, 20 tons of copper ore, 1,631 tons of lead ore, and 1,887 tons of copper-lead ore. The siliceous ores produced 24,440.50 fine ounces of gold and 147,830 ounces of silver, the copper ores yielded 19.98 ounces of gold and 874 ounces of

silver, the lead ores 598.78 ounces of gold and 49,432 ounces of silver, and the copper-lead ores 13.79 ounces of gold and 34,479 ounces of silver. The siliceous ore treated at gold and silver mills was 127,714 tons, and yielded $496,616 in gold and $19,914 in silver; the 9,993 tons of crude ore shipped to smelter yielded $13,514 in gold and $103,272 in silver, and the old tailings treated produced $8,176 in gold and $100 in silver.

Caliente and Ferguson districts.—In Caliente district the producing properties are the Na Quinta Range Mining Company and the Cherokee Nevada Copper Company. In Ferguson district the only producer was the Bamberger-Delamar Gold Mining Company, working the Delamar, Hog Pen, April Fool, and Magnolia mines, opened by a tunnel half a mile long. Near Delamar are several other properties all of which were idle during the year.

Eagle Valley and Stateline districts.—The B. and C. group at Eagle Valley was the only producer in the district, and made a small output. A number of mines were idle.

In Stateline district the Red Star Mines Company and the Frederick mine were the only producers, the latter yielding mainly lead. The output of both districts was small.

Pioche district (including Pioche or Ely Range, Bristol, Highland, and Jack Rabbit).—The total production of gold, silver, copper, and lead of the combined Pioche district in 1908 was valued at $195,586. This was from 9,922 tons of ore producing gold valued at $12,643, silver valued at $101,905, 274,682 pounds of copper valued at $36,258, and 1,066,191 pounds of lead valued at $44,780.

The principal producers were the Yuba East mine of the Boston and Pioche Mining Company, in the Ely Range or Pioche district proper; the Prince Consolidated mine of the Prince Consolidated Company, 2 miles west of Pioche; the Mendha mine of the Mendha Nevada Mining Company, at Highland, 8 miles to the northwest of Pioche; the Day mine of the Nevada-Utah Mines and Smelters Corporation, at Jack Rabbit, 14 miles northwest of Pioche, on the east side of the Ely Range; and the Bristol group of the Bristol Consolidated Mining and Smelting Corporation, at Bristol, 20 miles to the northwest of Pioche, on the west side of the range. The Old Timer mine, at Pioche, and the Highland Mary and Roden mines, at Highland, also made small productions of gold-silver-lead ores.

The Bristol group of claims, producing gold-silver-copper-lead ores, are developed by 4 inclines from 200 to 600 feet deep. The ore body is in limestone. The Day mine, at Jack Rabbit, producing oxidized silver-lead ore, is opened by an 800-foot shaft and is also in limestone. At Highland, the Mendha mine, producing gold-silver-copper-lead ore from ore bodies in limestone, is developed by a shaft 700 feet on the incline and 300 feet in the vertical depth. In the old Pioche or Ely Range district proper the Yuba East mine produces gold, silver, copper, and lead from a fissure in Ordovician quartzite in contact with the great Yuba porphyry dike. The Prince Consolidated mine has been actively developed and is now opened by an incline shaft 600 feet deep. The ores contain gold, silver, and lead, with manganese and calcite, and the deposits follow bedding and jointing planes in limestone. The famous old Meadow Valley and Ely properties, including the Burke mine, were not producers in 1908. These properties are now held by the Nevada-Utah Company. The Ohio-Kentucky Company also hold claims contiguous, and unwatering and

development of the old properties has been retarded pending settlement of questions of property rights. The latter company has also been developing the Susan Duster mine at Pioche.

There were no producing placers; but, although the extensive tailings and slags of earlier treatment of Pioche ores at Dry Valley, Condor Canyon, and Bullionville nearby have already been worked over, their metallic content is reported to be still large enough to justify re-treatment on a large scale.[a] There was considerable activity in prospecting, and in development of deep mines that did not produce in Pioche in 1908, and the famous old silver camp of the seventies may again become an important producer. New railroad and smelting rates have been offered for some of the Pioche ores on account of their desirable content of iron, manganese, or limestone.

The ore deposits of Pioche and vicinity are either fissure fillings in Ordovician quartzite or replacement bodies in overlying limestones and calcareous shales. The fissures are in quartzite alone, or follow the walls of nearly vertical porphyry dikes intrusive in the sediments. The deposits have recently been described by Pack.[b]

LYON COUNTY.

Lyon County in 1908 produced metals with a total value of $108,189 as compared with a value of $145,565 in 1907, a reduction for 1908 of $37,376. The product in 1908 was $88,189 in gold, $6,888 in silver, and 100,849 pounds of copper, valued at $13,312. There are 12 producing mines in the county, 11 of them being deep mines and 1 a placer mine. The bulk of the ore, or 13,760 tons out of a total of 14,120 tons, was siliceous. A nominal sum in gold was derived from a single small placer property at Dayton. The 3 productive districts of the county are Ramsey, Silver City, and Yerington.

Ramsey district.—The only producer in this district was the Ramsey Comstock Mining Company, whose mines are opened by an incline shaft 400 feet deep, with 4 levels. After the close of the year a reduction plant was installed, including a 50-ton Elspass mill, with plates and a cyanide plant.

Dayton and Silver City districts.—The Nevada Mining Reduction and Power Company operating the Ida and other claims, at Dayton, in Silver City district, has an 18-stamp mill driven by electric power, with a cyanide plant. The mine is developed by 2 shafts and by tunnels aggregating 4,000 feet in length. The Buckeye Mining Company was operating the entire year. The mine of the Silver City Gold and Silver Mining Company was worked principally by a lessee. The plant consists of a Bryan mill and concentrator. There were a number of small producers in Silver City district, and the total output of the district was valued at $90,400, of which $83,712 was in gold.

Yerington (Mason) district.—The principal producer in this copper district is the Nevada Douglas Copper Company, which was in operation the entire year. Among the developed properties were those of the Mason Valley, the Blue Jay, the Nevada Bonanza, the Yerington, and the Yerington Malachite copper companies; also the Bluestone mine.

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[a] Abbott, Jas. W., Pioche, Nev.; Min. and Sci. Press, vol. 95, 1907, p. 178.

[b] Pack, Fred J., Geology of Pioche, Nev. and vicinity: School of Mines Quarterly, vol. 27, Nos. 3 and 4, 1906.

NYE COUNTY.

Mine production of metals in Nye County, Nev., 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Pounds.*		*Pounds.*		
1907	74,855.86	$1,547,408	5,557,535	$3,667,973	9,096	$1,819	274,346	$14,540	$5,231,740
1908	148,733.10	3,074,586	7,632,813	4,045,391	167	22	180,976	7,601	7,127,600
Increase(+)or decrease(−)	+73,877.24	+1,527,178	+2,075,278	+377,418	−8,929	−1,797	−93,370	−6,939	+1,895,860

Nye was the most productive county in Nevada, ranking first with a total output valued at $7,127,600, an increase of $1,895,860 over the output of 1907. Besides being the first in value of total production, it ranked first in silver production and second in gold production. Within the borders of the county lie the important camp of Tonopah, as well as the productive districts of Bellehelen, Berlin, Bonnie Claire, Cloverdale, Tybo or Hot Creek, Johnnie, Manhattan, Marble or Lodi Valley, Goldyke, Millet, Reveille, Bullfrog, Round Mountain, Silver Bow, and South Klondike.

From the preceding table it appears that Nye County in 1908 yielded 148,733.10 fine ounces of gold, valued at $3,074,586, and that this was $1,527,178 more gold than the county produced in 1907, this being a very substantial gain and accounting mainly for the total increase in the county of $1,895,860 for the year. The silver output for 1908 was 7,632,813 fine ounces of a commercial value of $4,045,391. In quantity this was an increase of 2,075,278 fine ounces over the yield of 1907, but in value the increase was only $377,418, this being due to the low average price of silver in 1908. In both copper and lead the county showed reduced quantities and values as compared with the production of 1907.

Reports were received in 1908 from 99 productive mines in Nye County, which is double the number of producers shown in 1907. Of these 99 mines, 14 were placers, 3 of which are hydraulic, 7 drift, and 4 dry washing or sluicing properties. There were 85 deep mines, 53 of these being gold producers; 20, silver; 1, lead; 8, gold and silver; 1, gold-silver-lead; and 2, silver-lead. Nye County has more producing mines than any other county in the State. The total number of unproductive mines reporting for the year was 145. The 85 deep mines produced 389,204 tons of ore in 1908, of which 388,716 tons were siliceous and 488 tons were lead ores. The yield from the siliceous ore was 144,995.98 ounces of gold and 7,625,754 ounces of silver. From the lead ores there were recovered 301.96 ounces of gold and 5,123 ounces of silver. The increase in tonnage in 1908 over that of 1907 was 147,036 tons of ore. The tonnage of siliceous ore was by far larger than from any other county in the State, and the total tonnage was only exceeded by that of Whitepine County, where large quantities of copper ore were treated. Of the total ore, amounting altogether to 389,204 tons, 273,176 tons came from the district of Tonopah.

The total ore from Nye County treated at gold and silver mills in 1908 from all districts combined was 378,664 tons. This yielded in bullion $2,378,065 in gold, an average of $6.28 per ton, and $2,791,830 in silver, an average of $7.37 per ton. The total amount of both gold and silver was $5,169,895, an average recovery per ton of $13.65 in bullion.

From this milling ore and from 238 tons of crude ore sent direct to concentrating mills 3,282 tons of concentrates were produced. The yield from these concentrates was $396,804 in gold, an average of $120.90 per ton, and $932,642 in silver, an average of $284.17 per ton. The total value of gold and silver obtained from the concentrates was $1,329,446, an average of $405.07 per ton.

The total, 378,902 tons of ore milled, including that sent direct to the concentrator, yielded $2,774,869 in gold, or $7.32 per ton, and $3,724,472 in silver, an average of $9.83 per ton. The total gold and silver obtained was $6,499,341, an average recovery of $17.15 per ton.

There were shipped to smelters from Nye County 10,302 tons of ore, yielding under treatment $228,706 in gold, an average of $22.20 per ton, and $319,893 in silver, an average of $31.05 per ton. The total value of gold and silver in the smelting ore was $548,599, an average of $53.25 per ton.

The entire 389,204 tons of ore from the county treated by mills and smelters in 1908 yielded $3,003,575 in gold, or $7.72 per ton, and $4,044,365 in silver, or $10.39 per ton. The total gold and silver combined was valued at $7,047,940, an average recovery of $18.11 per ton. Including the values of the copper and lead produced in the county in 1908, the total output was valued at $7,055,563, an average value per ton of $18.13 for all metals.

The yield from the placers of the county in 1908 was 3,435.16 fine ounces of gold, valued at $71,011, and 1,936 fine ounces of silver, valued at $1,026, a total of $72,037. These placers are at Manhattan and Round Mountain.

Bellehelen district.—In this district the only producer of note was the Broken Hills Mining Company, the ore from which was all shipped to smelters. The operators of the Independence mine did considerable development work in 1908, and work was also done on the Elite mine. The Nevada-Bellehelen Mines Company installed engines and compressors and performed considerable development work. The Tomahawk Company, the Scioto-Nevada, and the Columbus-Nevada Mining companies, as well as the operators of the Lawrence and the Fourth Story mines, performed development work.

Berlin and Bonnie Claire districts.—In Berlin district the Goldfield Blue Bell Mining Company was the largest producer from the Berlin mine, which, however, was only operated for three months. The property is equipped with a 30-stamp mill and is developed by an incline shaft 800 feet deep. In Bonnie Claire district only one property was worked in a small way.

Bullfrog district.—From this important district there was in 1908 a yield valued at $645,457 in gold and $161,460 in silver, a total of $806,917 from 64,533 tons of ore. In 1907 the total output of the district was valued at $207,538, the increase for 1908 being $599,379. The district lies 60 miles southeast of Goldfield and the principal towns are Beatty, Bullfrog, Rhyolite, and Pioneer. Survey Bulletin No. 303 describes this district in detail. Of the output 62,017 tons

were milled and yielded in bullion $387,386 in gold and $58,991 in silver. The 494 tons of concentrates from this ore yielded $150,078 in gold and $64,032 in silver. There were also 2,516 tons of ore shipped to smelters, the yield from which was $107,993 in gold and $38,437 in silver.

At Beatty the Diamond Queen group was worked in 1908 by lessees, and the ore was shipped to smelters. The Shoshone Chieftain Mining Company, a large producer, has a 15-stamp mill with concentrators and a cyanide plant; 10 stamps of the mill were operated from July to December. The mine is developed by a 330-foot shaft and a tunnel 1,000 feet long. At Rhyolite the Bullfrog Gold Bar and the Bullfrog National Bank Mining companies yielded a moderate output. The property of the Bullfrog Pioneer Mining Company was leased, and only a low grade of milling ore was cyanided. The Bullfrog West Extension Mining Company made test shipments only during the year.

The Gibraltar Mines Syndicate shipped its ore to smelters. The Homestake King Consolidated Mining and Milling Company built a 25-stamp plate-amalgamation mill and cyanide plant in 1908 and operated for three months of the year. The mine is opened by an incline shaft 500 feet deep and about 4,000 feet of drifts. The Montgomery Shoshone Mines Company, the largest producer in the district, includes the Shoshone-Polaris Mining Company. It is equipped with a 150-ton mill with concentrators. The vertical shaft on the property is 700 feet deep and the tunnel is 450 feet long. About 7,000 linear feet of underground work was done in 1908. The Tramp Consolidated Mining Company shipped its ore to smelters.

Among the developing operators near Beatty are the Beatty Mountain Mining Company and the Bullfrog Cliff, Doris Montgomery, Inyo Gold, Manganese Bullfrog, Red Oak, Shoshone Bullfrog, Sunset, Wabash, and Bullfrog Mining companies. At Rhyolite a new shaft is being sunk on the Bullfrog Gold Reef Mining Company's property. The Bullfrog Rampart Mining Company has leased its mine. The property of the Bullfrog Syndicate Mines Company was actively developed. The mines of the Bullfrog Mining Syndicate were worked both on company account and by lessees.

Cloverdale and Tybo districts.—From Cloverdale district there was only a small production from 2 deep mines. From Tybo or Hot Creek district operators of 2 mines reported output, the principal one being the Nevada Smelting and Mines Corporation. Considerable lead came from this district and a nominal quantity of copper.

Goldyke district.—The producing mines in this district were the D'Arcy and those of the Nevada Garfield Consolidated Mining Company, Pactolus Mining Company, Shaffer, and Silver Summit Mining Company. The total yield from 169 tons of ore treated was valued at $9,177 in gold, silver, copper, and lead.

Johnnie district.—This district made a total yield in 1908 valued at $36,445, of which $36,333 was in gold, from 212 tons of ore produced by the Bullfrog Johnnie, Crown Point Globe Mining Company, and Johnnie Consolidated Mining Company.

Liberty and Lodi Valley districts.—In each of these districts the yield was made from a single mine. The Lodi Mines Company is the producer in Lodi Valley or Marble district, and the Tonopah Liberty Mining Company is the one at Liberty.

Manhattan district.—The total yield of this district in 1908 from deep and placer mines was valued at $267,674, an increase of $234,052 over the value of the yield of 1907. The placer mines are all drift properties except one, which is a dry placer. The total yield from these placers in 1908 was $16,371, mainly in gold. Since the close of the year placer discoveries in this district have caused considerable excitement. The deep mines of Manhattan district made from 10,769 tons of ore a yield valued at $248,075 in gold and $3,228 in silver, a total value of $251,303. All of this was from milling ores, except $3,009 in gold and $578 in silver, which was obtained from 24 tons of ore worked at the smelter. The Bronco Manhattan and Manhattan Peak Gold Mining companies yielded some production. The Union No. 2 mine was worked the entire year. The Manhattan Consolidated Mines Company worked its property part of the year and had the ore treated at local mills. The Manhattan Union Extension Mining Company had the work done under lease the entire year. The Manhattan Thelma Mining Company made a small yield only, as did the Manhattan Crescent Mining Company. Lessees carried on operations during the entire year in the mine of the Manhattan Dexter Mining Company of Nevada. Considerable shaft sinking and drifting was accomplished in 1908 in the mine, which was the most productive in the camp. The Manhattan Earl Mining Company operated part of the year only. The Manhattan Gold Crater Mining Company made a trial shipment of ore. The Manhattan Thanksgiving Mining Company was a small producer, as was the Manhattan Wolftone Mining Company. There were also a few other mines which made a small production. The placer producers at Manhattan in 1908 were the Dorknell, the Golden Gate Mining Company, Mustang Extension, Manhattan Combination, Manhattan Crescent Mining Company, Manhattan Gold Wedge Mining Company, and Manhattan Verde.

Millet and Reveille districts.—From Millet district a small production was reported from 2 properties, and from Reveille district only 1 operator reported production.

Round Mountain district.—The total output of this district in 1908 was valued at $447,531, of which $392,233 was derived from deep mines and $55,298 was from placers. In 1907 the deep mines yielded $122,261, the increase from this source being $269,972 in 1908; and the placers yielded $49,310 in 1907, the placer mine increase being therefore $5,988 in 1908. The total increase in output of the district in 1908 over that of 1907 was $275,960. The 35,352 tons of siliceous ore treated in 1908 yielded $384,886 in gold and $7,347 in silver. The Round Mountain Mining Company was the principal producer in the camp, as it was in 1907. This company has a reduction plant of 2 Nissen stamps, 2 Huntington mills, and 1 tube mill. The property is developed by an incline shaft 700 feet deep. During 1908 there were 400 feet of shaft sinking accomplished and 2,500 feet of drifting. The Combination Mining Company had its ore worked at a custom mill, as did the operators of the Evening Fraction mine. The Round Mountain Antelope Mining Company's property was operated under lease continuously during 1908. The Round Mountain Fairview mine is equipped with a 5-foot Huntington mill. The plant was operated six months. The Round Mountain Sphinx Mining Company, a large producer, installed a crusher and

Huntington mill. There were several other producing properties in the district in 1908, none of which made any large output. The producing placers were those of the Round Mountain Combination Mining Company, Round Mountain Blue Jacket Mining Company, Mulholland, and Thatcher and Round Mountain Hydraulic Gold Mining Company.

Of the unproductive mines the Gold Hill Consolidated Mining Company performed development work. The Round Mountain Daisy Mining Company has 2 vertical shafts and a tunnel and did some sinking, drifting, and crosscutting in 1908. Several thousand tons of ore were extracted. The 50-ton Merrall mill was completed in January, 1909, and has since been running.

Silver Bow district.—From this district in 1908 there were obtained $5,219 in gold and $7,357 in silver, a total of $12,576. The Nevada Silver Bow Mining Company shipped its ore. The Silver Bow Belle Mining Company got all its ore from the Gift mine; development in 1908 consisted of a shaft 176 feet deep and a 220-foot tunnel. The Silver Bow Mining Company and several other properties made a small output.

South Klondike and Hanapah districts.—In Hanapah district the Silver Glance Mining Company was the only producer. At South Klondike the South Klondike Mining Company was the only mine making any output. The ore of this mine yields largely in silver.

TONOPAH DISTRICT.

Mine production of Tonopah district, Nye County, Nev., in 1907 and 1908.

	Gold.		Silver.		Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Pounds.*		*Pounds.*		
1907	57,258.00	$1,183,628	5,370,891	$3,544,788	5,939	$1,188	195,508	$10,362	$4,739,966
1908	78,584.75	1,624,491	7,172,396	3,801,370					5,425,861
Increase (+) or decrease (−)	+21,326.75	+440,863	+1,801,505	+256,582	−5,939	−1,188	−195,508	−10,362	+685,895

The following table shows the gold and silver production of the Tonopah district from 1902 to 1908, inclusive:

Mine production of gold and silver in Tonopah district, Nye County, Nev., from 1902 to 1908, inclusive, in fine ounces.

Year.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
1902	26,462.58	$547,030	2,434,453	$1,217,241	$1,764,271
1903	25,297.61	522,948	2,404,180	1,274,215	1,797,163
1904	18,703.03	386,626	2,115,191	1,205,659	1,592,285
1905	58,356.99	1,206,346	5,369,439	3,243,141	4,449,487
1906	63,113.75	1,304,677	5,697,928	3,817,612	5,122,289
1907	57,250.36	1,183,470	5,330,398	3,518,063	4,701,533
1908	78,584.75	1,624,491	7,172,396	3,801,370	5,425,861
	327,769.07	6,775,588	30,523,985	18,077,301	24,852,889

The value of the production of Tonopah district in 1908 increased $685,895 over that of 1907. The increase was in both gold and silver, but more largely in gold. No output of copper or lead was reported from the district in 1908, though there was some yield in both metals in 1907. Reports were received from operators of 13 productive mines in 1908, as compared with 10 in 1907. These mines were all deep mines, and produced altogether 273,176 tons of ore in 1908, which yielded $1,624,491 in gold and $3,801,370 in silver. Of this ore, 266,891 tons were treated at gold and silver mills, yielding in bullion $1,300,952 in gold, an average of $4.87 per ton, and $2,720,803 in silver, an average of $10.20 per ton. The bullion yield of this milling ore in both gold and silver was $4,021,755, an average of $15.07 per ton.

From this milling ore 2,698 tons of concentrates were saved and yielded $243,085 in gold, an average of $90.10 per ton, and $863,103 in silver, an average of $319.90 per ton. The total value of both gold and silver in the concentrates was $1,106,188, an average of $410 per ton.

The milling ore thus produced a total of $1,544,037 in gold, an average recovery of $5.78 per ton. The ore also yielded a total of $3,583,906, or an average of $13.43 per ton, in silver. The ore milled averaged therefore a total recovery of $19.21 per ton in both gold and silver.

The ore shipped to smelters amounted to 6,285 tons, yielding $80,454 in gold, or $12.80 per ton, and $217,464 in silver, or $34.60 per ton. The total value of gold and silver derived from the ores smelted was $297,918, an average of $47.40 per ton.

From the total quantity of Tonopah ores milled and smelted in 1908 was obtained an average yield of $5.95 per ton in gold and $13.91 per ton in silver, or an average yield per ton of all classes of ore in both metals of $19.86 per ton. The average value per ton, on the same basis, in 1907 was $22.03.

The most productive mining property in Tonopah district continues to be that of the Tonopah Mining Company. This company treated all its ore at the 100-stamp concentration and cyanide mill of the Desert Power and Mill Company, at Millers, 14 miles from Tonopah. The mine is developed by vertical shafts, the Mizpah shaft being 1,274 feet deep, the Silver Top No. 1, 700 feet deep, and the Red Plume 419 feet. During 1908 the company did 9,323 feet of drifting, 2,748 feet of crosscutting, and cut 1,797 feet of winzes and raises. The property of the Jim Butler Tonopah Mining Company, a large producer also, is opened by a shaft 725 feet deep. All the ore mined in 1908 was treated at the Belmont mill, at Millers. The MacNamara Mining Company was under injunction in all but a limited part of the mine until August, 1908, and did not produce to its capacity until after that date. The ore was handled by the Western Ore Purchasing Company and the Montana-Tonopah Mining Company. The vertical shaft in the mine is 1,580 feet deep. The property of the Montana-Tonopah Mining Company is developed by a vertical shaft 860 feet deep, with 5 main levels, aggregating about 35,000 feet of development. The company owns a 40-stamp concentration and cyanidation mill. The concentrates and cyanide precipitates have been sold to a smelting company, but since the close of the year the company has erected furnaces to treat the precipitates. The Tonopah North Star Tunnel and Development Company

operated its mine and mill continuously during the year. The mill has 60 stamps, 12 Wilfley tables, 8 Johnson concentrators, and a cyanide plant. The shaft in this mine is 1,127 feet deep. The mine of the Tonopah Extension Mining Company is developed by a shaft 1,050 feet deep, of which 300 feet were sunk in 1908. The Tonopah Midway Mining Company has an 800-foot shaft, and 5,285 feet of development work was done in 1908. The West End Consolidated Mining Company has 3 vertical shafts, the deepest of which is 780 feet deep. The company did 4,473 feet of development work during the year. The ore was milled by the Belmont Development Company, at Millers. A few other properties in the district made small yields during 1908.

The property of the Baxter Springs Mining and Milling Company was worked by lessees, but the ore was left on the dump, cost of transportation and treatment being considered prohibitive.

STOREY COUNTY.

Mine production of metals in Storey County, Nev., in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Pounds.*		*Pounds.*		
1907	12,320.63	$254,690	162,791	$107,442	2,717	$543	2,373	$126	$362,801
1908	29,006.47	599,617	542,017	287,269	.....	.....	.....	.....	886,886
Increase (+) or decrease (−)	+16,685.84	+344,927	+379,226	+179,827	−2,717	−543	−2,373	−126	+524,085

Storey County, within the borders of which is the famous Comstock lode, was for many years the most productive of the counties of Nevada. It was only when the known Comstock bonanzas were exhausted and the mines became less and less productive that other counties began to exceed it in product.

Continued effort, however, has since been made to prospect and develop the Comstock lode from one end to the other, and these efforts are being attended with success. The record of Storey County is virtually the record of the Comstock, and it may be noted that a very satisfactory increase in output has been made. The total production in 1908 was valued at $886,886, an increase of $524,085 over the record of 1907. The increase in value of gold output was $344,927 and in that of silver, $179,827.

The mines of the county produced 103,708 tons of ore in 1908, and 10,200 tons of tailings were treated. The total yield from this tonnage was 29,006.47 fine ounces of gold, valued at $599,617, and 542,017 ounces of silver, valued at $287,269, a total value in both gold and silver of $886,886. No copper or lead ores were mined in 1908, though small quantities were mined in 1907. All the ore produced in 1908 was siliceous. Of the total tonnage, 97,506 tons were treated at gold and silver mills. The bullion yield was $382,269 in gold and $143,048 in silver. From this milling ore were obtained 491 tons of concentrates, yielding by subsequent treatment $59,148 in gold and $30,604 in silver. There were also 6,202 tons of ore treated at smelting works, yielding $147,831 in gold and $101,154 in silver. In addition to this 10,200 tons of tailings brought returns of

$10,369 in gold and $12,463 in silver. Storey County holds second rank in the production of silver in the State, being exceeded only by Nye County. There were 26 producing mines in the county in 1908, all deep mines, as compared with 21 in 1907.

The Comstock Mining and Milling Company treated a large quantity of tailings in its cyanide plant during 1908. The Ohio Tonopah Mining Company, operating the Overland mine at Gold Hill, made quite a material output, as did the Silver Hill Mining Company. A good deal of ore and tailings from the old dumps of the Imperial, Trojan, and Overman mines were handled in a leased 15-stamp mill and 50-ton cyanide plant. The Yellow Jacket mine is equipped with a mill consisting of 20 Kinkead crushers and 30 Johnson concentrators. Ore was taken from the 1,100-foot shaft and the 600-foot tunnel in 1908. The properties of the Chollar Gold and Silver Mining Company were under lease to Charles Butters & Co. (Limited), who have a 20-stamp mill and cyanide plant. The ore treated was from the croppings of these mines. The Comstock Tunnel Company ran its 15-stamp amalgamation and concentration mill on dump rock the entire year. The Consolidated California and Virginia Mining Company did not operate any mill, but sold its crude ore to Charles Butters & Co. (Limited), and its concentrates to the Selby Smelting and Lead Company. The Hale & Norcross Mining Company worked its property through the vertical shaft and sent the ore out through the Sutro tunnel from the 1,600-foot level. The ore was milled at a custom mill and concentrates were sold to the smelter. The ore treated in 1908 was mined in 1907, none having been extracted from the mine in 1908, when work was confined to prospecting and developing. The Lady Bryan Mining Company only operated for two months, and the ore was treated in a 5-stamp mill. The Ophir Mining Company was the most productive mine on the Comstock in 1908, as it was in 1907. The mine was worked through the shaft of the Consolidated California and Virginia Mining Company. The ore obtained was sold to Charles Butters & Co. (Limited), and the concentrates were sold to the smelter. The Haphazard mine made a small output, the ore being treated in a 5-stamp mill. Several mines of less importance made small yields by having their ore treated at local custom mills.

Among the nonproducers, the Belcher Silver Mining Company operated on a small scale during the year, considerable prospecting and repairing of the upper levels having been done; the Sierra Nevada Mining Company did prospecting only; the Andes Mining Company took out some ore, but it was placed on the dump and not milled; the Best & Belcher Mining Company, with a Kinkead mill and concentrators, did not operate. Other idle mines were those of the Gould & Curry, Justice, Julia Consolidated, Mexican, Occidental Consolidated, Savage, Scorpion, Union Consolidated, and Utah Mining companies.

The situation on the Comstock was considered somewhat in detail in the report of 1907, and no very marked changes have occurred since that time.

WASHOE COUNTY.

The total yield of Washoe County in 1908 was valued at $14,871, as compared with $113,856 in 1907, a reduction in value for the year 1908 of $98,985. There were only 968 tons of ore produced in the

county in 1908, and they yielded $14,156 in gold, $161 in silver, and $554 in copper. In 1907 there were 256,067 pounds of lead and 200,000 pounds of zinc produced in this county, but no lead or zinc yield was reported in 1908.

Deep Hole and West Comstock districts.—Neither of these districts made much of a production in 1908, and there was only 1 productive mine reported in each district. The output was mainly gold in both districts.

Olinghouse district.—The total output of this district in 1908, from 4 properties, was valued at $6,816, of which $6,759 was gold. The number of tons of ore treated was 569, all of which was milling ore. The Emma L. Gold Mining and Milling Company operated only three months of the year and crushed its ore in a Chile mill. The Springfield-Nevada Mining Company was a small producer. The Olinghouse Nevada Mining Company, working the Renegade mine, did considerable development work and ran a 2-stamp mill a short time; the mine is opened by a 700-foot tunnel. The Nevada Consolidated Mill and Mining Company and the Nevada Green Hill Mining Company were involved in litigation and no work was done; these properties have a 50-stamp mill. The Buster Company, owning the Monitor, Independence, Dispensia, and Macya mines, performed considerable development work. Mining affairs in the district were very dull during the year, mainly owing to the shut-down of the Nevada Consolidated Mining Company.

Peavine district.—The mines in this district yielded from 141 tons of ore $3,390, most of which was gold, with a small amount of silver and of copper. Very few properties were operated in 1908.

Cottonwood district.—This district, 12 miles north of Pyramid Lake, at Round Hole, was quite active fifteen or twenty years ago, and some development work was done in 1908 on the Wild Horse mine, but there was no output.

WHITEPINE COUNTY.

Mine production of metals in Whitepine County, Nev., in 1907 and 1908.

Year.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Pounds.*	
1907	2,863.41	$59,192	55,678	$36,747	68,821	$13,764
1908	5,030.61	103,992	83,017	43,999	14,839,493	1,958,813
Increase (+) or decrease (−).	+2,167.20	+44,800	+27,339	+7,252	+14,770,672	+1,945,049

Year.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
1907	1,477,190	$78,291	14,400	$850	$188,844
1908	1,595,882	67,027	.....	.....	2,173,831
Increase (+) or decrease (−)	+118,692	−11,264	−14,400	−850	+1,984,987

Whitepine County in 1908 exceeded its total output in 1907 by the remarkable value of $1,984,987, which was due almost entirely to the greatly increased product of the large copper mines in Ely district. There was some increase in gold and some in silver, but in neither case was it very material. The quantity of lead increased, but the value showed a decrease for 1908, as compared with 1907. There was no zinc production in the county in 1908, though there were a few thousand pounds obtained in 1907. The copper increased from the small quantity of 68,821 pounds in 1907 to 14,839,493 pounds in 1908. For the same period the increase in value of copper was from $13,764 to $1,958,813. The largest quantities of lead were from Whitepine (Hamilton) and Ward districts, and almost the whole of the copper was derived from Ely district.

Reports were received from 28 producing mines in Whitepine County in 1908, of which 3 were drift mines. Of the deep mines, numbering 25 and classified according to chief product, 6 were gold, 5 silver, 3 copper, 7 lead, 1 gold and silver, 1 silver-copper, 1 silver-copper-lead, and 1 silver-lead.

These deep mines of the county produced in 1908 a total of 433,777 tons of ore, of which 1,202 tons were siliceous ores; 430,014 tons, copper ores; 2,321 tons, lead ores; and 240 tons, copper-lead ores. The quantity of ore treated at gold and silver mills was only 203 tons, yielding $3,341 in gold and $16 in silver. Of crude ore shipped to smelters there was 2,780 tons, yielding $2,024 in gold and $21,941 in silver. The quantity of ore treated at concentrating mills was 430,794 tons, yielding 38,817 tons of concentrates. From these concentrates were obtained $94,554 in gold, $22,023 in silver, 14,788,134 pounds of copper, and 39,678 pounds of lead. The siliceous ore treated yielded 256.24 ounces of gold and 36,472 ounces of silver; the copper ores yielded 4,568.53 ounces of gold and 22,873 ounces of silver; from the lead ores were obtained 8.66 ounces of gold and 19,938 ounces of silver; and from copper-lead ores, 0.15 ounce of gold and 3,698 ounces of silver. The deep mines of the county therefore yielded 4,833.58 fine ounces of gold and 82,981 ounces of silver. The gold yield from placers was 197.03 fine ounces.

Cherry Creek district.—Small production was reported by the Biscuit Mining Company and by the North Mountain Mining Company. The Hartford Nevada Gold Mining Company, operating the Joanna and Joanna No. 2 mines, did no work in 1908, but shipped some ore which had been mined in 1907. The Vulcan Mining, Smelting, and Reduction Company did mainly development work, amounting to 2,000 feet. Of the nonproducers the Cherry Creek Mines Company and the Stewart Gold Mines Holding Company performed development work. The total output of this district in 1908 was valued at $12,191.

Granite and Duck districts.—In Granite or Steptoe district the Bunker Hill and Sullivan Mining Company and the Campbell's Mining Company were the only producers. In Duck Creek district the Lead King Mill and Mining Company, operating the Gray Eagle and Star Mines, made some production of lead.

Ely district.—The entire copper output of the State of Nevada in 1908 was 15,598,788 pounds, valued at $2,059,040, and that from Ely district was 14,797,295 pounds, valued at $1,953,243. In addition, the district produced $94,443 in gold, $16,102 in silver, and

2,381 pounds of lead, valued at $100. The value of the entire metallic output of Ely district in 1908 was therefore $2,063,888.

The district output of ore in 1908 was 430,031 crude tons, of which 106 tons yielding $191 in gold and $6,979 in silver were treated at the smelter. Of the crude ore in the district sent to concentrating mills, there were 429,925 short tons, which made 38,689 tons of concentrates. These concentrates contained $94,252 in gold, $9,123 in silver, and 14,776,363 pounds of copper, valued at $1,950,480. In addition to the copper from the concentrates, 20,932 pounds were obtained from the smelting of crude ore.

The most important copper producer in the district was the Nevada Consolidated Copper Company, whose mines are worked by open cut and shafts. The ore is concentrated at the Steptoe Valley plant. The mine was in operation in 1908 from July to the end of December, and both the concentrator and the smelter from August to the end of the year. The Cumberland Copper Company makes the same disposition of its ore as does the Nevada Consolidated. The Giroux Consolidated Mining Company was only in operation for two months of 1908. During that time it took smelting ore from the Alpha mine, and concentrating copper ore from the Morris, Bunker Hill, and Brooks mines; the concentrating mill is to be enlarged. A few smaller properties in this district were also productive. The systems of mining and methods of ore treatment in this district have been fully described in detail in the various technical journals. On the property of the Nevada Consolidated work is done on a very extensive scale by steam shovels. The copper occurs as chalcocite or gray copper disseminated in an altered monzonite or monzonite porphyry. The average recovery is about 1.75 per cent of copper, and the ore contains besides 5 cents in gold and 2 cents in silver per ton.

Hamilton district.—Hamilton or Whitepine district yielded $27,479 in 1908 from 429 tons of ore. In detail the gold yield was $182, the silver $5,412, the copper 3,660 pounds, valued at $483, and the lead, 509,572 pounds, valued at $21,402. The main values of the district are seen to be in the lead ores. Most of this ore was crude, shipped direct to smelter, but some concentrates were made by one mine in the district. The producing mines reported were the Paroni, Coyote, Dog Star, Jennie O, and McEllin, and the mines of the Black Rock Mining Company and the Rocco-Homestake Mining Company.

Osceola district.—The total output of this district in 1908 was valued at $5,137, of which the placers produced $4,073 in gold and $19 in silver, a total of $4,092. Only 143 tons of ore were produced during the year, yielding $1,041 in gold and $4 in silver. The quartz producers were the Boston Nevada Mining Company, the Black and the Weeks mines, and the Pilot Knob Mining and Milling Company. The last has a small prospecting mill with a concentrator. The placers are all drift mines and are those of the Gold Bar Placer Mining Company, the Osceola, the Blue Gravel Placer Company, and the Osceola Leasing Company.

Newark and Ward districts.—From Newark district only 1 producer reported, the Newark Mining and Milling Company, operating the Bay State mine. The largest proportion of its output was in silver, with some copper and lead and a small quantity of gold. In Ward district there is also but 1 producer, the Nevada United Mines Company, operating the Paymaster and Good Luck claims. Development

on the properties continued throughout the year, but ore shipments did not begin until September. This mine is developed by a tunnel 2,400 feet long, and about 3,500 feet of development work was done in 1908. Ward district is 15 miles south of Ely.

NEW MEXICO.

By Charles W. Henderson.

PRODUCTION.

According to the returns received from the mines, the total value of the output of gold, silver, copper, lead, and zinc in New Mexico for the calendar year 1908 was $1,525,091. The gold yield was 14,452.37 fine ounces, valued at $298,757; the silver yield, 405,044 fine ounces, valued at $214,673; the copper, 6,112,630 pounds, valued at $806,867; the lead, 873,763 pounds, valued at $36,698; and the zinc, 3,576,516 pounds, valued at $168,096. As compared with 1907, there was a falling off in the total production, the largest decrease being in the copper yield, which decreased 4,877,385 pounds in quantity and $1,391,136 in value; this decrease was mainly in Grant and Dona Ana counties, the yield from Otero County showing an increase in quantity and a decrease in value. The lead output of the Territory decreased 2,936,118 pounds. Zinc increased 2,826,431 pounds, from operations in Socorro County. The total decrease in value was $1,714,732.

There were 134 producing mines in the Territory in 1908, of which 108 were deep and 26 were placer mines, as compared with 127 producers in 1907, of which 104 were deep and 23 were placer mines.

There were 135,434 short tons of ore sold or treated in 1908, which averaged $11.09 in value per ton, as compared with 219,992 tons, averaging $14.64 per ton, in 1907. The decreases in tonnage were in siliceous, copper, and lead ores; the increases, in zinc ores. The average value per ton in 1908 in gold and silver was $12.34 in siliceous ore; 97 cents in copper ores; $2.18 in lead ores; and $26.38 in copper-lead ores.

During 1908, there were treated in gold and silver mills in New Mexico 27,121 tons of ore, and the bullion saved amounted to $127,475 in gold, at an average per ton of $4.70, and $89,949 in silver, at an average per ton of $3.32; the total value in gold and silver being $217,424, at an average of $8.02 per ton. From 58,486 tons treated at mills by concentration only there were produced 4,818 tons of concentrates, valued at $44,638 in gold, at an average per ton of $9.26, and $65,215 in silver, at an average per ton of $13.54, the total in gold and silver being $109,853, at an average of $22.80 per ton.

From the 85,607 tons to both classes of mills there were produced $172,113 in gold, from both bullion and concentrates, at an average recovery of $2.01 per ton, and $155,164 in silver, at an average recovery of $1.81 per ton, a total in gold and silver of $327,277, at an average of $3.82 per ton in these two metals for all ore milled.

Crude ore shipped to smelters amounted to 49,827 tons, containing $103,446 in gold, averaging $2.08 per ton; $59,428 in silver, averaging $1.19 per ton; the total in gold and silver being $162,874, and the average per ton $3.27.

Mine production of gold, silver, and associated metals in New Mexico in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	15,962.88	$329,982	14,452.37	$298,757	− 1,510.51	− $31,225
Silver.....do....	705,544	465,659	405,044	214,673	− 300,500	− 250,986
Copper.....pounds..	10,990,015	2,198,003	6,112,630	806,867	−4,877,385	−1,391,136
Lead.....do....	3,809,881	201,924	873,763	36,698	−2,936,118	− 165,226
Zinc.....do....	750,085	44,255	3,576,516	168,096	+2,826,431	+ 123,841
	.....	3,239,823	.....	1,525,091	.....	−1,714,732

The following table shows the production of gold, silver, copper, lead, and zinc in New Mexico, in 1908, by counties:

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1908, by counties.

County.	Producing mines.	Tonnage.	Gold.		Silver.	
			Quantity.	Value.	Quantity.	Value.
			Fine ounces.		*Fine ounces.*	
Colfax	9	.....	545.38	$11,274	66	$35
Dona Ana	5	3,090	.....	.....	9,283	4,920
Grant	57	75,254	2,209.87	45,682	95,477	50,603
Lincoln	13	4,399	1,437.32	29,712	5,472	2,900
Luna	5	288	.14	3	1,077	571
Otero	12	22,418	1,726.50	35,690	4,351	2,306
Rio Arriba and Taos	4	450	892.28	18,445	604	320
Santa Fe	6	7	98.25	2,031	6	3
Sierra	11	680	871.62	18,018	8,589	4,552
Socorro	12	28,848	6,622.05	136,890	280,091	148,448
Unapportioned	.....	.....	48.96	1,012	28	15
	134	135,434	14,452.37	298,757	405,044	214,673

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Colfax	.....	.....	.....	.....	.....	.....	$11,309
Dona Ana	21,150	$2,792	379,697	$15,948	.....	.....	23,660
Grant	5,242,767	692,045	244,589	10,273	251,070	$11,800	810,403
Lincoln	1,195	158	.....	.....	.....	.....	32,770
Luna	5,934	783	127,535	5,356	.....	.....	6,713
Otero	723,907	95,556	.....	.....	.....	.....	133,552
Rio Arriba and Taos	85,341	11,265	99,794	4,191	.....	.....	34,221
Santa Fe	.....	.....	.....	.....	.....	.....	2,034
Sierra	12,874	1,699	6,075	255	.....	.....	24,524
Socorro	19,462	2,569	16,073	675	3,325,446	156,296	444,878
Unapportioned	.....	.....	.....	.....	.....	.....	1,027
	6,112,630	806,867	873,763	36,698	3,576,516	168,096	1,525,091

Tonnage of ore sold or treated, number of deep mines producing, by counties, and average value per ton of ore mined in New Mexico in 1907 and 1908.

County.	Short tons of ore sold or treated.		Number of deep mines producing.	
	1908.	Increase (+) or decrease (−).	1907.	1908.
Dona Ana	3,090	− 2,994	5	5
Grant	75,254	−71,492	45	52
Lincoln	4,399	− 1,368	7	10
Luna	288	− 1,760	9	5
Otero	22,418	+10,215	10	9
Rio Arriba, San Miguel, Taos, Mora, and Santa Fe	457	−21,513	8	5
Sierra	680	− 20	8	10
Socorro	28,848	+ 4,374	12	12
Total	135,434	−84,558	104	108
Average value per ton			$14.64	$11.09

The production of precious and other metals in New Mexico often shows violent changes, and the operations of a single mine sometimes swing the principal production from one metal to another. In 1907, as compared with 1906, there was an increase in copper, and a great decrease in zinc. In 1908 there was a decrease in copper, chiefly from the closing of a mine and smelter in Grant County and in Santa Fe County; and there was also a great decrease in the yield of lead during 1908. The renewed activity of a zinc property in Socorro County made a creditable increase in that metal. The shipments from Sylvanite in 1908 had very little effect on the total gold production.

Number of mines in New Mexico, classed by chief product, in 1908, by counties.

County.	Gold placer mines.			Deep mines.									Total mines producing.
	Dredge.	Hydraulic.	Surface.	Gold.	Silver.	Copper.	Lead.	Zinc.	Gold-silver.	Gold-copper.	Silver-lead.	Copper-lead.	
Colfax	....	2	7	....	....	....	....	....	....	....	....	....	9
Dona Ana	....	....	....	....	....	3	1	....	....	....	1	....	5
Grant	....	....	5	11	6	19	8	1	4	3	....	....	57
Lincoln	....	....	3	7	2	1	....	....	....	....	....	....	13
Luna	....	....	....	....	....	2	1	....	....	....	2	....	5
Otero	....	....	3	....	....	8	....	....	....	1	....	....	12
Rio Arriba	....	....	....	1	....	....	....	....	....	1	....	1	3
Santa Fe	....	....	4	2	....	....	....	....	....	....	....	....	6
Sierra	....	....	1	4	5	1	....	....	....	....	....	....	11
Socorro	....	....	....	2	....	4	2	3	1	....	....	....	12
Taos	....	....	1	....	....	....	....	....	....	....	....	....	1
	....	2	24	27	13	38	12	4	5	5	3	1	134

GOLD.

The total value of the gold production in New Mexico in 1908 was $298,757, as against $329,982 in 1907, a decrease of $31,225. Socorro County alone produced $136,890, or 46 per cent of the total gold yield. This was almost entirely from siliceous ore. This class of ore furnished, in the whole Territory, 9,544.82 fine ounces, valued at $197,309, or 66 per cent of the total, Grant, Lincoln, and Socorro counties furnishing the bulk of the gold-bearing siliceous ore. Copper ores furnished 3,757.09 fine ounces, valued at $77,666, or 26 per cent of the total, Grant, Otero, Rio Arriba, and Sierra counties furnishing the gold-bearing copper ores. The greater part of the remaining 8 per cent of gold came from placers.

The production from different kinds of ore, with increases and decreases, as compared with 1907, is shown in the following table:

Source of gold production in New Mexico by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placer mines.	Deep mines.					Total.
		Dry or siliceous ore.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead ores.	
Colfax	545.38						545.38
Dona Ana							
Grant	169.99	1,393.97	617.65	26.27		1.99	2,209.87
Lincoln	39.47	1,396.06	1.79				1,437.32
Luna			.14				.14
Otero	71.35		1,655.15				1,726.50
Rio Arriba, Santa Fe, and Taos	151.32	28.20	811.01				990.53
Sierra	95.73	108.02	667.87				871.62
Socorro		6,618.57	3.48				6,622.05
Unapportioned	48.96						48.96
Total 1908	1,122.20	9,544.82	3,757.09	26.27		1.99	14,452.37
Total 1907	935.56	12,034.78	2,326.90	665.64			15,962.88
Increase (+) or decrease (−)	+186.64	−2,489.96	+1,430.19	−639.37		+1.99	−1,510.51

SILVER.

The silver yield in 1908 amounted to 405,044 fine ounces, valued at $214,673, as compared with 705,544 fine ounces, valued at $465,659, in 1907, a decrease for 1908 of 300,500 ounces in quantity and of $250,986 in value. Of the total, Socorro County produced 280,091 ounces, or 68 per cent, chiefly from siliceous ores; Grant County, from siliceous, copper, lead, and copper-lead ores, furnished 95,477 ounces, or almost 24 per cent of the total. The yield of silver from Grant and Socorro counties was therefore 92 per cent of the total for the Territory. Lead ores and silver-lead ores furnished 14,870 ounces, or 3.6 per cent of the total; siliceous ore, 364,335 ounces, or 89.9 per cent; and copper ores, 24,768 ounces, and copper-lead ores, 918 ounces, these two making 6.3 per cent of the total.

Source of silver production in New Mexico, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placer mines.	Deep mines.					Total.
		Siliceous or dry ores.	Copper ores.	Silver-lead and lead ores.	Zinc ores.	Copper-lead ores.	
Colfax	66						66
Dona Ana			453	8,830			9,283
Grant	30	78,243	12,238	4,640		326	95,477
Lincoln	4	308	5,160				5,472
Luna			68	1,009			1,077
Otero	11		4,340				4,351
Rio Arriba, Santa Fe, and Taos	8	10				592	610
Sierra	6	6,153	2,151	279			8,589
Socorro		279,621	358	112			280,091
Unapportioned	28						28
Total 1908	153	364,335	24,768	14,870		918	405,044
Total 1907	173	542,252	115,323	45,393			[a] 705,544
Increase (+) or decrease (−)	−20	−177,917	−90,555	−30,523		+918	−300,500

[a] 2,403 ounces lead-zinc ores reported in 1907. None in 1908.

COPPER.

The copper output of New Mexico decreased from 10,990,015 pounds, valued at $2,198,003, in 1907, to 6,112,630 pounds, valued at $806,867, in 1908, a lower output for 1908 by 4,877,385 pounds, and a decrease in value of $1,391,136. This decrease was chiefly from Grant and Santa Fe counties. Grant and Otero counties, in 1908, yielded together 5,966,674 pounds, or 97.6 per cent, of the total 6,112,630 pounds. Other decreases were in Dona Ana County, 754,975 pounds, and in Socorro County, 169,183 pounds. The total increases from Lincoln, Luna, Otero, and Sierra counties were 58,105 pounds.

LEAD.

The lead production decreased from 3,809,881 pounds, valued at $201,924, in 1907, to 873,763 pounds, valued at $36,698, in 1908, a loss of 2,936,118 pounds in quantity and of $165,226 in value. All the lead-producing counties, Dona Ana, Grant, Luna, Sierra, and Socorro, showed decreased production.

ZINC.

Grant and Socorro counties were the only producers of zinc in New Mexico in 1908. The two counties yielded 3,576,516 pounds, valued at $168,096. Socorro County produced 3,325,446 pounds, an increase of 2,649,090 pounds, and Grant County produced 251,070 pounds, an increase of 177,341 pounds.

The yield of the zinc mines at Magdalena, in Socorro County, in 1908 was 93 per cent of the total. The Ozark Smelting and Mining Company and the Tri-Bullion Smelting and Development Company are the most important companies in the district.

SMELTERS.

The El Paso smelter continued to handle a large portion of the ores of New Mexico in 1908. In Arizona, the Copper Queen smelter, at Douglas, also received copper ores from southwestern New Mexico. The Comanche smelter, at Silver City, N. Mex., was closed in December, 1907, and remained closed during 1908. The Southwest

Smelting and Refining Company, which blew in its 250-ton furnace at Oro Grande, Otero County, on November 6, 1907, ran successfully until May, 1908. The Santa Fe Gold and Copper Company, at San Pedro, Santa Fe County, which had closed its 125-ton matting plant in October, 1907, did not open it during 1908. The lead smelter of the National Mining and Smelting Company, at Deming, Luna County, was idle during 1908.

Subdivision of tonnage of ore sold or treated in New Mexico in 1908, by counties, in short tons.

County.	Siliceous or dry ore.	Copper ores.	Silver-lead and lead ores.	Zinc ores.	Copper-lead ores.	Total.
Colfax						
Dona Ana		160	2,930			3,090
Grant	4,327	70,145	449	313	20	75,254
Lincoln	4,296	103				4,399
Luna		35	253			288
Otero		22,418				22,418
Rio Arriba, Santa Fe, and Taos	17	270	170			457
Sierra	490	186	4			680
Socorro	22,512	42	53	6,241		28,848
Total 1908	31,642	93,359	3,859	6,554	20	135,434
Total 1907	46,486	164,849	5,873	405		[a] 219,992
Increase (+) or decrease (−)	−14,844	−71,490	−2,014	+6,149	+20	[a] −84,558
Average recovered value per ton in gold and silver	$12.34	$0.97	$2.18		$26.38	$3.61

[a] 2,379 tons of lead-zinc ores reported in 1907. None in 1908.

REVIEW BY COUNTIES.

COLFAX COUNTY.

The production of Colfax County in 1908 was all from placer mines. The value of the yield from 9 placers, the same number as in 1907, was $11,274 in gold and $35 in silver, a total of $11,309. This is $660 less than in 1907. Over three-fourths of the production came from the Moreno district, near Elizabethtown, and the rest from placers on Ute Creek, near Haldy.

As in 1907, development work only was reported from the lode mines of the county. The Gold and Copper Tunnel Mining and Milling Company, at Elizabethtown, is driving an adit, which is now 2,600 feet in length.

DONA ANA COUNTY.

Mine production of gold, silver, and associated metals in Dona Ana County, N. Mex., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	0.29	$6			− 0.29	− $6
Silver.....do....	25,612	16,904	9,283	$4,920	− 16,329	− 11,984
Copper.....pounds..	776,125	155,225	21,150	2,792	−754,975	−152,433
Lead.....do....	675,189	35,785	379,697	15,948	−295,492	− 19.837
		207,920		23,660		−184,260

This county in 1908 ranked seventh in New Mexico in value of production. The total output was from the Organ district alone, near the towns of Organ and Kent. As shown by the table, there was a large decrease in the yield for 1908, as compared with that of 1907. There was a notable decrease in the copper output, and the lead yield was a little over one-half of the production of 1907. There were 5 producing mines in the district. The total tonnage sold or treated was 3,090 tons.

Some copper ore was shipped from the Torpedo mine. The property of the Memphis Copper Company, the chief copper mine in the camp, has been worked by lessees for the last thirty-five years. The mine is opened by a shaft 175 feet deep and a tunnel 400 feet long. The Stephenson-Bennett Consolidated Mining Company increased the capacity of its 50-ton concentrating plant to 300 tons in 1908, and shipped both crude ore and concentrates to the El Paso smelter. The shaft on the property was sunk from 400 feet to 600 feet in 1908. The Mormon Mining and Milling Company reported development work.

GRANT COUNTY.

Mine production of gold, silver, and associated metals in Grant County, N. Mex., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	5,468.41	$113,042	2,209.87	$45,682	− 3,258.54	− $67,360
Silver.....do....	224,279	148,024	95,477	50,603	− 128,802	− 97,421
Copper.....pounds..	8,046,315	1,609,263	5,242,767	692,045	−2,803,548	− 917,218
Lead.....do....	1,394,390	73,903	244,589	10,273	−1,149,801	− 63,630
Zinc.....do....	73,729	4,350	251,070	11,800	+ 177,341	+ 7,450
	.....	1,948,582	.....	810,403	.....	−1,138,179

The yield from Grant County in 1908 again took first place in point of value and also in point of tonnage with an output of 75,254 tons of ore, though this is a falling off as compared with the production of 1907 of almost 50 per cent. In production of copper Grant County ranked first, producing 85.8 per cent of the total; in production of gold, silver, lead, and zinc Grant County ranked second to Socorro County. Grant and Socorro counties were the only counties to produce zinc. There were 52 producing deep mines in 1908.

The placer yield from 5 mines in the Eureka and Pinos Altos districts showed a slight decrease.

Compared with the output of 1907, there was a decrease of all the metals in Grant County except zinc. The greatest decrease was in copper, the chief product of the county. The total difference in the value of all the metals for the two years was $1,138,179.

Siliceous and dry ores (carrying copper under 4½ per cent) amounted to only 4,327 short tons, as compared with 21,832 tons in 1907, a decrease of 17,505 tons. Copper ores maintained the tonnage for the county, with 70,145 tons, though this is 52,685 tons less than the production in 1907. The remaining 782 tons were lead, copper-lead, and zinc ores.

The bulk of all the ore mined went to concentrating mills. From the 55,038 tons concentrated were produced 4,139 tons of concentrates (at a ratio of 13 to 1), the average value per ton of which was $1.19 in gold and 42 cents in silver. The chief value of these concentrates was in copper.

There were 20,212 tons of ore sent direct to the smelters, the average value of which per ton was $1.84 in gold and $2.42 in silver, a total in gold and silver of $4.26 per ton.

Apache district.—The yield from this district, southeast of Hachita, was slightly above that of 1907. The foremost mine in the district is that owned by the Anderson-Apache Copper Company. From August to the end of the year the company shipped copper ore carrying gold and silver to the Copper Queen smelter at Douglas, Ariz. The shaft was sunk 150 feet in 1908 to a total depth of 300 feet. The workings include also 5,000 feet of drifts and crosscuts. A small shipment was made by the Hachita Copper Development Company, which has performed development work on the Star and Quien Sabe claims.

Burro Mountain district.—The chief ore of this camp, which lies southwest of Silver City, near Leopold and Tyrone, is copper. There was a greatly lessened output of this metal in 1908. The Burro Mountain Copper Company, at Leopold, continued development work during the year and ran the 300-ton concentrating mill about one-fourth of the time on ore extracted in development work. The Comanche and Copper Gulf holdings consolidated as the Savannah Copper Company. The Comanche smelter was idle in 1908. The Chemung Copper Company, which has been developing its claims for two and one-half years, sunk an incline shaft 200 feet in 1908. On the 31 claims are 3 vertical shafts, 532 feet, 421 feet, and 725 feet deep, respectively.

Central district.—The Central district, embracing the towns of Fierro, Bayard, Hanover, and Santa Rita, maintained its position in 1908 as the most productive district in Grant County, though the yield of copper fell from 4,994,575 pounds in 1907 to 3,994,502 pounds in 1908 and the value from $1,000,000 to a little more than $500,000. There were 10 producing mines, many of them small.

The Santa Rita Mining Company, at Santa Rita, the largest producer of copper in New Mexico, made a better record than in 1907. The mine and mill were run continuously with both day and night shifts. The mill is a 100-ton concentrating plant, using crusher, rolls, jigs, and tables. Practically all the development work in 1908 consisted in surface prospecting by means of cuts and shallow shafts and in sinking 7,750 feet of prospect holes with churn drills.

The Copper Queen Consolidated Mining Company operated the Hanover, Modoc, and Emma mines. The Empire Zinc Company operated the Metal King, Southwestern, and Lone Star mines, in the Hanover camp, with a yield in zinc alone. The Philadelphia Copper Mines Company, at Hanover, spent the year in blocking out ore, and was expecting to ship in 1909. There are 3 shafts on the property, 264 feet, 150 feet, and 75 feet deep, respectively. Some copper ore was shipped from the Pewabic mine and some zinc ore from the Black Jack mine, at Hanover, and at Bayard there was some lead-silver ore shipped from the Lucky Bill mine by lessees. Some gold

ore and a little high-grade native gold were also shipped from the Lost mine. The Columbia Copper Company, at Santa Rita, continued development work throughout 1908.

Chloride Flat district.—The shipments of this silver and lead-silver camp, near Silver City, were less than those of 1907. The value of lead and silver combined was $21,234. The producing mines were the Grand Central, the Baltic, and the Gold Coin.

Eureka district (including Sylvanite).—The mining district which embraces the Little Hatchet Range, in southwestern Grant County, was called Eureka by the first American prospectors. Old Hachita, on the east side of the range, and not far distant from Hachita, on the El Paso and Southwestern Railway, has been the principal point where mining has been carried on by Americans in the range. In 1907 lead, silver, and copper, valued at $30,080, were produced near Old Hachita by the Copper Dick group, the Hornet mine, and the King mine. In 1908 there was no production from the Hornet. This mine is opened by a vertical shaft 150 feet deep and an incline shaft 200 feet deep. The American mine, belonging to the owners of the Hornet mine, is opened by a vertical shaft 200 feet deep, of which 85 feet were sunk in 1908. Only development work was done on the Copper Dick group. In 1908 the Mariposa Mining Company, owning the King mine, shipped a car of copper ore taken out in doing assessment work. The Gold Hill Mining and Milling Company shipped some high-grade gold ore containing silver and copper. The Tucson placer produced gold from sluicing operations. In October, 1908, a new gold strike was made on the western slope of the Little Hatchet Mountains, about 12 miles southwest of Hachita station. Many claims were staked out and a town named Sylvanite was established. During 1908 there were shipped 133 tons of ore averaging $27 in value per ton. Tetradymite, a telluride of bismuth, has been reported to occur in the ore of this new camp.

Granite Gap district.—From this district the U. S. and Mexico Development Company shipped lead-silver ore to the smelter.

Lordsburg district (including Pyramid and Virginia districts).—There was a decided decrease in production from Lordsburg, from the Virginia district 4 miles to the southwest, and from the Pyramid district 8 miles south.

In the Virginia district copper ore, carrying gold and silver, was shipped by the Bonnie Mining Company, by the Eighty-Five Mining Company, and by the Miner's Chest Mining Company. Gold and silver ore, carrying copper, was shipped from the Superior, Goodsight, and Glow mines.

The Nellie Bly mine, in the Pyramid district, was reported idle in 1908.

Pinos Altos district.—The only producing mine of note in the Pinos Altos district was the Aztec mine, whose ores carry gold, silver, and copper. There were 11 producing deep mines in all, but the output for 1908 was small in comparison with the yield of 1907. Shipments were made from the Arizona Number 2, the Jersey Bell, the Ferum, the Gillett dump, and other mines. The placer yield was one-half that of 1907. The idleness of the Pinos Altos properties of the Comanche Company explains the heavy falling off in production.

Red Hill district.—This district is situated near the southwestern corner of New Mexico. The Red Hill Mining Company operated continuously during the year. At the close of the year several shipments of lead-silver ore were made. The shaft on the property is down 300 feet.

Steeple Rock district.—Steeple Rock is in the northwestern part of the county and is reached from Duncan, Ariz. Shipments of highly siliceous ore, carrying gold and silver, from the Alabama and the Laura mines made a substantial increase in the production of the district for 1908. The workings on the Alabama consist of one shaft 165 feet deep and another shaft 80 feet deep, connected by 500 feet of drifts. The workings on the Laura consist of one shaft 300 feet deep and one shaft 183 feet deep, connected by 2,000 feet of drifts and crosscuts.

White Signal district.—From the White Signal district, near Silver City, two small shipments of copper ore were made in 1908.

LINCOLN COUNTY.

The total value of the production of 1908 in Lincoln County was $32,770, or $9,123 less than in 1907, the decrease being entirely in gold and in the output from the Bonita and Nogal district. The output of both silver and copper increased in quantity and value. There were 10 producing deep mines, and 3 placers, the latter in the Jicarilla district. The tonnage sold or treated was 4,399 short tons.

Cedar Creek district.—The shipments from this district in 1908, though small, were in excess of the output of 1907. The chief product is silver, with a little copper and gold. Shipments were made from the Lucky and Return mines near Alto.

Jicarilla district.—The output from this district, near the town of that name, was gold, from deep mines and placer. The value of both deep and placer yield was almost three times as much as the production of 1907. The Wisconsin Mining and Smelting Company, operating the Murphy group, treated a large tonnage of gold ore in their 40-ton plant on the property—a 6-foot roller mill, with 2 Standard tables. The Good Luck mine and the mill were operated during three months in the spring of 1908. The placer gold was won by sluicing.

Nogal district (including Bonita).—This district embraces the towns of Nogal, Parsons, and Bonita. The yield of 1908 was very much less than that of 1907. The Eagle Mining and Improvement Company worked its mine by open cuts and built a 200-ton cyanide plant, reporting a production from operations covering thirty days in testing the plant. The Vera Cruz Mining Company also replaced its Huntington mills with a 200-ton cyanide plant during 1908.

White Oaks district.—The production from White Oaks district in 1908 was about the same as in 1907. The Wildcat Leasing Company, on the North and South Homestake mines, was the foremost producer in the district. The workings of these mines consist of a 1,000-foot vertical shaft, 1,200 feet of tunnel, and a winze 200 feet deep. The mill has 20 stamps, with amalgamating plates, but only 10 stamps were used. Lessees on the Old Abe mine prospected the upper levels, and treated the ore in a 20-stamp plate-amalgamation and cyanide plant. The depth of the shaft on this property is 1,428 feet. The

Home Leasing Company was also a producer. The ore of these three mines is chiefly gold. Some copper ore was shipped from the Yellow Jacket mine, in this vicinity.

LUNA COUNTY.

The total value of the production of Luna County in 1908 was $6,713, as compared with $73,646 in 1907. The major part of the output for both years was from lead. The smelter of the National Mining and Smelting Company was closed in 1908.

Cooks Peak district.—There were 3 shippers in 1908, as against 6 in 1907. The value of the output was only one-eighth the value of 1907. The producing mines were the Desdemona and Inez, the Onstott, and the White Oaks. Ore was mined by the Cooks Peak Mining Company, but was not sold.

Tres Hermanas district.—Two small shipments of copper ore were made from this district in 1908.

Victorio and Florida districts.—There was no production in the Victorio and Florida districts in 1908.

MORA COUNTY.

There was no production in Mora County in 1908. The Republic Mines Company, at Lucero, was occupied in erecting a 25-ton smelting plant for copper ores. The plant is to be completed early in 1909.

OTERO COUNTY.

Mine production of gold, silver, and copper in Otero County, N. Mex., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	716.48	$14,811	1,726.50	$35,690	+1,010.02	+$20,879
Silver.....do....	2,135	1,409	4,351	2,306	+ 2,216	+ 897
Copper.....pounds..	679,480	135,896	723,907	95,556	+ 44,427	− 40,340
	.....	152,116	.....	133,552	.....	− 18,564

The production from deep mines in Otero County was 22,418 short tons in 1908, an increase of 10,215 tons over the output of 1907. In quantity, gold, silver, and copper production showed substantial increases, but the value of copper was $40,340 less than in 1907. The total decrease in value for the county, balancing the gold and silver increase against the copper decrease, was $18,564. The total value of the three metals was $133,552, of which $35,690 was gold, $2,306 silver, and $95,556 copper. The placer gold yield was $1,475, against a nominal yield in 1907.

Highrolls district.—In this district, near Mountain Park, the Hunt Copper Company operated for ten months of the year and shipped considerable copper ore. There was another small shipment from this district.

Silver Hill district.—The smelter and mines of the Southwest Smelting and Reduction Company, at Oro Grande, were operated in

1908 continuously from January until May. The smelter is a 250-ton copper matting plant. The company's mines, the Lucky, By Chance, Nannie Baird, and others, have in mine openings and workings 5 vertical shafts from 90 to 480 feet deep, 3 incline shafts from 200 to 800 feet deep, and 2 tunnels 600 and 1,450 feet long. The Garnet group was worked under lease. The incline shaft on this property is 470 feet deep. Shipments were made from the Delusion, Providence, and Copper Hill mines. The First National Mining Company, J. P. Nocker, and the Texas-Jarilla Placer Mining Company worked placer mines by sluicing.

Tularosa district.—The Tularosa Copper Company did only development work in 1908. The 30-ton plant, consisting of a crusher, rolls, tables, and jig, was deemed too small to work at a profit.

RIO ARRIBA COUNTY.

From 3 mines, in 3 districts, there was a total production for Rio Arriba County in 1908, valued at over $30,000, chiefly in gold, copper, and lead.

The Keystone-Bromide Mining Company, of Tres Piedras, in the Bromide district, shipped considerable high-grade copper ore, carrying gold. The shaft on this property is 250 feet deep. The Red Jacket Mining and Milling Company, of Tusas, in the Headstone district, treated a small tonnage in its 6-foot Huntington mill, with 1 Card concentrator attached. There is a 125-foot shaft in this mine. Shipments of lead ore were made from the Gallina district. The Las Tusas Mining and Milling Company, a producer of copper in 1907, made no yield in 1908. There are several placer companies near Tusas, preparing to operate in 1909.

SAN MIGUEL COUNTY.

There was some development work done in this county, near Chapelle and Tecolote, but there was no production.

SANTA FE COUNTY.

Santa Fe County, which ranked third in the Territory in total value of production, and second to Grant County in yield of copper in 1907, produced $2,034 in gold and silver in 1908, and no copper—a decrease in value of $273,836. Of the yield of 1908, 88 per cent was from placers in the Cerillos and New Placers districts, near the towns of Golden and San Pedro. The rest was from two very small shipments of gold ore, from Golden. This decrease was caused by the closing down of the Santa Fe Gold Copper Mining Company's smelter at San Pedro during 1908, and the confinement of work to development of the mines. At Cerillos, the Boston-Cerillos Mines Corporation retimbered and unwatered the Cash Entry mine to the 300-foot level. The shaft is 650 feet deep. The erection of a 200-ton concentrating plant was begun in September, 1908.

SIERRA COUNTY.

In 1908 the total value of the mineral production in Sierra County showed an increase of $13,224 as compared with that of 1907. The yield of gold, silver, and copper increased, but there was a small

decrease in output of lead. The total value of all the metals was $24,524. Part of the gold increase was from placer production in Lake Valley.

Black Range district.—At the Virginia mine, at Kingston, the 40-ton concentration plant was operated on dump ore during the spring of 1908. The concentrate carried silver alone.

Las Animas district.—Most of the county yield came from the Las Animas district, near Hillsboro. The Sigma Consolidated Development Company shipped copper ore, carrying gold and silver, from the Wicks mine. Operations during part of the year were confined to making connections with the old workings, which were full of water. The workings include a 300-foot vertical shaft, a 260-foot incline shaft, and 3,000 feet of drifts. The Ready Pay Reduction Company, with a mill equipment of 2 Huntington mills, crusher, amalgamating plates, and Wilfley tables, operated on company account from January to April. After this only desultory work by lessees was done. There were several other small shippers from this district.

Palomas district.—From this district, near Hermosa, some lead-silver ore and concentrate were shipped by the Ocean Wave Mining Company, which also completed a 20-stamp concentration mill. The Palomas Chief mine was operated during the entire year. A considerable tonnage of lead-silver-zinc-copper sulphide was mined, but none marketed.

SOCORRO COUNTY.

Mine production of gold, silver, and associated metals in Socorro County, N. Mex., in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	5,099.98	$105,426	6,622.05	$136,890	+ 1,522.07	+$31,464
Silver.....do....	422,744	279,011	280,091	148,448	− 142,653	−130,563
Copper.....pounds..	188,645	37,729	19,462	2,569	− 169,183	− 35,160
Lead.....do....	707,981	37,523	16,073	675	− 691,908	− 36,848
Zinc.....do....	676,356	39,905	3,325,446	156,296	+2,649,090	+116,391
	.....	499,594	.....	444,878	.....	− 54,716

Socorro County in 1908, with a slightly lessened yield in total value of all the metals, took second place in county rank. In gold and zinc production Socorro County easily stood first. The zinc output, though an increase over the yield of 1907, was 13,718,717 pounds less than that of 1906.

Cooney (or Mogollon) district.—The greater part of the gold and silver produced in the county came from this district, in the southwest corner of the county. Usually this district produces the bulk of the copper of the county, but there was no yield of copper in 1908. There was an increase in gold production, but a decrease in silver yield.

The Ernestine Mining Company, operating the Last Chance mine at Mogollon, is the largest producer of gold in New Mexico. The reduction plant at the mine consists of a 20-stamp plate-amalgamation mill, with concentrators and cyanide plant. The capacity of the

plant is 60 tons per day, and both mill and mine were operated during all of 1908. Development work consisted in raising, 886 feet; in driving tunnel, 1,081 feet; and in sinking, 130 feet. At Cooney the Enterprise Mining Company operated its mines for nine months. The workings consist of an incline shaft 300 feet deep, connected with an adit 650 feet long, at the portal of which is the mill. A 100-ton cyanide plant was under construction in 1908. The work on the mines of the Mogollon Gold and Copper Company was development only. Some ore was taken out in development work on the Top mine and the Trilby mine.

Magdalena district.—This central-western district of Socorro County is a lead-zinc camp. The production of lead in 1908 was only nominal, but the production of zinc was 3,325,446 pounds, an increase as compared with that of 1907 of 2,649,090 pounds.

The Ozark Smelting and Mining Company, operating the Graphic and the Ida Hill groups, was one of the chief producers of zinc. The old workings on these properties include an incline shaft 305 feet deep and about 7 miles in other openings; the new workings consist of 6,837 feet of tunnels, drifts, crosscuts, and raises. The ore is used in making zinc oxide at the company's smelter at Coffeyville, Kans. The Tri-Bullion Smelting and Development Company operated the Kelly mine about six months of the year, and shipped a large tonnage of zinc ore and concentrate to smelters. The concentrating plant has a capacity of 100 tons. From the Juanita mine zinc carbonate ore was shipped. The Mine Development Company, on the Key group, shipped oxidized lead-silver ore. A large tonnage was blocked out, but on account of low metal prices only a few cars of ore were shipped. A car of copper ore was shipped from the Wheel of Fortune mine at Magdalena.

Rosedale district.—The Rosedale Mining and Milling Company, at Rosedale, south of Magdalena, produced gold and silver bullion during six months in 1908.

Oscura district.—Estey City, in the southeastern corner of Socorro County, is the center of this district. The small yield was entirely in copper. Producing mines in 1908 were the Dividend, the Lucky Andy, and the Sunrise.

TAOS COUNTY.

There was one placer producing mine in Taos County in 1908, operated by the La Grande Gold Mining Company. Development work was reported by companies near Red River and Twining.

UNION COUNTY.

The Fort Pitt Copper Company, in the Black Mesa district, near Kenton, Okla., reported a total of 650 feet of shafts and 500 feet of tunnel on the property.

OREGON.

By Charles G. Yale.

PRODUCTION.

For the calendar year 1908 operators of 239 mines, of which 66 were quartz and 173 were placers, reported production from Oregon. The aggregate output of these mines was valued at $926,737. Of this total the gold yield was 41,848.05 fine ounces, valued at $865,076; the silver yield was 43,602 ounces, valued at $23,109; the copper, 291,377 pounds, valued at $38,462, and the lead 2,138 pounds, valued at $90. In 1907 the total value of all the metals produced in Oregon was $1,297,316, so that the decrease in value of output for 1908 as compared with that of 1907 was $370,579. The total quantity of ore mined and treated in 1908 was 50,684 tons, a decrease as compared with that of 1907 of 60,014. The siliceous ores amounted to 48,551 tons in 1908, a decrease of 55,087 tons as compared with the production of 1907, and the copper ores, amounting to 2,133 tons, decreased 4,927 tons as compared with the output of 1907. This material decrease in tonnage accounts for the falling off in yield of both gold and silver as well as of copper. The average value of siliceous ore per ton in gold and silver in 1908 was $12.49, and the average value per ton in gold and silver of the copper ore was $2.82. The average recovered value per ton of all metals was $12.50 in the siliceous ores in 1908 and $20.78 in the copper ores.

There were treated in 1908 at gold and silver mills 47,869 tons of ore, containing $517,354 in gold and $11,188 in silver. In milling the ore $339,531 in gold and $5,608 in silver were recovered by ordinary plate amalgamation, the average being $7.09 in gold and 12 cents in silver per ton. The concentrates saved from this ore were 1,842 tons in quantity, valued at $177,823 in gold and $5,580 in silver, or an average of $96.54 in gold, and $3.03 in silver per ton. The average extraction in gold and silver mills, both by amalgamation and in the concentrates, was $10.81 in gold and 23 cents in silver. Crude ore shipped to smelters amounted to 2,815 tons, valued at $75,129 in gold and $8,820 in silver, an average of $26.69 in gold and $3.13 in silver per ton.

The statement of production of 1907 and 1908, showing increase and decrease, of gold, silver, and associated metals in Oregon, valued at each year's commercial prices, is as follows:

Mine production of gold, silver, and associated metals in Oregon in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Pounds.*		*Pounds.*		
1907	54,628.00	$1,129,261	86,718	$57,234	554,104	$110,821	.....	.....	$1,297,316
1908	41,848.05	865,076	43,602	23,109	291,377	38,462	2,138	$90	926,737
Increase (+) or decrease (−)	−12,779.95	−264,185	−43,116	−34,125	−262,727	−72,359	+2,138	+90	−370,579

GOLD.

The total output of gold in Oregon in 1908 was 41,848.05 fine ounces, valued at $865,076, a decrease of 12,779.95 fine ounces in quantity and $264,185 in value, as compared with the output of 1907. The largest yield of gold, valued at $123,116, came, as usual, from Baker County, although this was a reduced yield as compared with that of 1907. The next county in rank of gold production was Josephine, followed by Grant, Jackson, Douglas, Malheur, and Curry in the order named. The largest production of deep mines was from Baker County, and of placer mines from Josephine County. The most productive quartz mine in the State is in Baker County, and the most productive placer (hydraulic) is in Josephine. Sixty-four quartz mines produced gold in 1908, 1 more than in 1907. Productive placer mines numbered 173 in 1908, as compared with 141 in 1907. The placers in 1908 yielded $272,593 in gold, as compared with $331,406 in 1907. The hydraulic mines in 1908 yielded $180,982 in gold, which is $58,023 less than in 1907; and the surface placers, dredges, and drift mines yielded $91,611, which is $790 less than in 1907. The falling off in gold yield from placer properties in Oregon in 1908 was therefore $58,813, as compared with the output of 1907. There were in the State 85 productive hydraulic mines, 5 drift mines, 1 dredge, and 82 surface placers or sluicing mines.

The gold production from different kinds of mines, by counties, for 1908, is given in the following table:

Source of gold product in Oregon, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Deep mines.			Grand total.
		Siliceous ores.	Copper ores.	Total.	
Baker	1,857.45	22,713.61	.....	22,713.61	24,571.06
Benton	26.12	.....	.....	.....	26.12
Coos	77.59	2.90	.....	2.90	80.49
Curry	338.34	91.91	.....	91.91	430.25
Douglas	760.21	159.64	.....	159.64	919.85
Grant	1,106.87	3,180.90	.....	3,180.90	4,287.77
Harney	43.78	.....	.....	.....	43.78
Jackson	2,517.58	720.30	.....	720.30	3,237.88
Josephine	5,639.94	1,468.00	281.99	1,747.99	7,387.93
Lane	.....	42.38	.....	42.38	42.38
Malheur	711.07	.....	.....	.....	711.07
Umatilla	38.46	.....	.....	.....	38.46
Union	15.48	.....	1.74	1.74	17.22
Wallowa	4.69	.....	.....	.....	4.69
Wheeler	49.10	.....	.....	.....	49.10
Total	13,186.68	28,377.64	283.73	28,661.37	41,848.05
Increase (+) or decrease (−)	−2,845.09	−9,484.35	−450.51	−9,934.86	−12,779.95

The following table shows the source of placer gold in Oregon, by counties, in 1908:

Source of placer gold in Oregon in 1908, by counties.

County.	Hydraulic mines.	Surface placers, drift, and dredging.	Total value.
Baker	$15,573	$22,824	$38,397
Benton		540	540
Coos		1,604	1,604
Curry	2,502	4,492	6,994
Douglas	14,385	1,330	15,715
Grant	17,422	5,459	22,881
Harney		905	905
Jackson	14,462	37,581	52,043
Josephine	102,355	14,233	116,588
Malheur	14,283	416	14,699
Umatilla		795	795
Union		320	320
Wallowa		97	97
Wheeler		1,015	1,015
Total	180,982	91,611	272,593
Increase (+) or decrease (−)	−58,023	−790	−58,813

SILVER.

The yield in silver in Oregon in 1908 aggregated 43,602 fine ounces, valued at $23,109, a decrease of 43,116 ounces in quantity and of $34,125 in value, as compared with the production of 1907. Grant County made the largest silver output—17,987 fine ounces, valued at $9,533—but Baker County was a close second, its yield for the year being 17,495 fine ounces valued at $9,273. Josephine County came next with a product of 6,007 ounces, valued at $3,184. None of the other counties in the State produced as much as $1,000 during the year. The placer mines of the State yielded 5,851 ounces of silver in 1908, which is 3,060 ounces more than was shown in the figures for 1907. The quartz mines yielded 37,751 ounces, of which 37,464 ounces came from siliceous and 287 from copper ores. The siliceous ores showed a falling off in silver content of 45,616 ounces, as compared with 1907, the entire decrease, including silver from copper ore, being 46,176 ounces. Considering the increased silver output from the placers, and the decrease from the quartz mines, the total reduction of silver output was 43,116 fine ounces in 1908, as compared with the production of 1907.

The source of silver, by kinds of ore and by counties, in 1908 is shown in the following table:

Source of silver product in Oregon, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placer.	Deep mines.			Grand total.
		Siliceous ores.	Copper ores.	Total.	
Baker	409	17,086		17,086	17,495
Benton	4				4
Coos	18	2		2	20
Curry	35	10		10	45
Douglas	201	208		208	409
Grant	623	17,364		17,364	17,987
Harney	10				10
Jackson	769	585		585	1,354
Josephine	3,664	2,066	277	2,343	6,007
Lane		143		143	143
Malheur	96				96
Umatilla	10				10
Union	4		10	10	14
Wheeler	8				8
Total	5,851	37,464	287	37,751	43,602
Increase (+) or decrease (−)	+3,060	−45,616	−560	−46,176	−43,116

COPPER.

The copper output in Oregon in 1908 was 291,377 pounds, valued at $38,462, a decrease in quantity, as compared with 1907, of 262,727 pounds and in value of $72,359. Most of the copper was derived from Josephine County, though small quantities came from Grant, Lane, and Union counties. There were 2,133 tons of copper ore treated in 1908, which was 4,927 tons less than in 1907. The average value per ton in all metals recovered from this copper ore was $20.78, of which $2.82 was in gold and silver. The low price of copper during the year 1908 was the cause of the material falling off in quantity of copper ore treated.

MINING INDUSTRY IN OREGON IN 1908.

As pointed out on a preceding page, the decrease in the total output of metals amounted to $370,579 in 1908. The decline is shown in gold, silver, and copper, the greatest being in the gold output. Both placers and deep mines showed a material decrease in yield. This does not appear to be for the reason that many important mines which were productive in 1907 ceased operations in 1908, but from the fact that there was a generally reduced yield from the productive mines at work. As may be noted in this chapter under the heading of "Production by counties," many properties were operated only a portion of the year, while many others which continued development work did not operate their reduction plants at all. The tonnage treated from the deep mines was reduced by about one-half. The average recovery per ton, however, was higher in 1908 than it was in 1907. There were 66 productive deep mining properties and 173 placers in 1908. Both classes increased in numbers, yet the total yield of both classes is materially lessened as noted. The decreased yield in placer gold was mainly from the hydraulic mines. The main decrease in gold output was in the deep mining operations. There were 15 counties in the State which made more or less production of metals in 1908. Over half the total gold was derived from Baker County, the next county in importance being Josephine, which has taken from Jackson the second place in county rank. Grant County comes third in importance, Jackson thus being placed fourth in rank in 1908. All the counties showed a decrease of tonnage except Douglas and Union, where there was merely a nominal increase.

In placer gold output the counties of Benton, Coos, Curry, Douglas, Grant, Harney, Malheur, Wheeler, Wallowa, and Umatilla increased their output in 1908 over that of 1907. The greatest increase was in Douglas, followed by Grant County. But the counties of Baker, Jackson, Josephine, and Union decreased their total yield as compared with that of 1907. The largest falling off was in Jackson County, where it was $55,056. Combined losses and combined gains being considered, the total placer gold decrease for the production of 1908 as compared with that of 1907 was $58,813. Practically all of this was due to lessened output in hydraulic mining.

Southwestern and northeastern Oregon form two distinct mining regions, which differ in character of deposits and ores. The mines in southwestern Oregon may be considered as in the extension of

the gold belt of California. The counties comprising this region are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. In 1908 their combined gold production was $250,644, which is a reduction of $145,834 from the output of 1907. The placer gold from this region in 1908 amounted to $193,484, or a decrease of $46,458 as compared with the output of 1907. The gold production from the deep mines was $57,160, which was a decrease of $99,376 from the record of 1907. The silver production in southwestern Oregon in 1908 was 7,982 fine ounces.

Northeastern Oregon comprises Baker, Grant, Harney, Malheur, Union, Wallowa, and Wheeler counties, some of which are comparatively unimportant as far as mining production is concerned, while one is the most important mining county and by far the largest producer in the State. The combined gold yield of these counties in 1908 was $614,432, which was $118,139 less than in 1907. The placer gold yield was $79,109 in 1908, or $12,355 less than in 1907. The lode mines yielded $535,323 in gold, which was $105,784 less than in 1907. The silver production of northeastern Oregon was 35,620 fine ounces.

The following table shows the production of gold, silver, copper, and lead in Oregon in 1908, by counties:

Mine production of gold, silver, copper, and lead in Oregon in 1908, by counties.

County.	Gold.		Silver.		Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine oz.		*Fine oz.*		*Pounds.*		*Pounds.*		
Baker	24,571.06	$507,929	17,495	$9,273					$517,202
Benton	26.12	540	4	2					542
Coos	80.49	1,664	20	10					1,674
Curry	430.25	8,894	45	24					8,918
Douglas	919.85	19,015	409	217					19,232
Grant	4,287.77	88,636	17,987	9,533	503	$67			98,236
Harney	43.78	905	10	5					910
Jackson	3,237.88	66,933	1,354	718					67,651
Josephine	7,387.93	152,722	6,007	3,184	289,645	38,233			194,139
Lane	42.38	876	143	76	629	83	2,138	$90	1,125
Malheur	711.07	14,699	96	51					14,750
Umatilla	38.46	795	10	5					800
Union	17.22	356	14	7	600	79			442
Wallowa	4.69	97							97
Wheeler	49.10	1,015	8	4					1,019
	41,848.05	865,076	43,602	23,109	291,377	38,462	2,138	90	926,737

The following table shows, by counties, the tonnage of ore, concentrates, and tailings in Oregon in 1907:

Tonnage of ore, concentrates, and old tailings in Oregon in 1908, by counties, in short tons.

County.	Total tons of ore sold or treated.	Increase (+) or decrease (−) compared with 1907.	Concentrates produced.		Old tailings treated.
			Quantity.	Value in gold and silver.	Quantity.
Baker	38,413	−31,468	1,636	$175,477	10,000
Coos	3	− 1	1	21	
Curry	10	− 25			500
Douglas	120	+ 120			
Grant	5,251	− 3,807	141	5,665	
Jackson	3,293	−11,630	60	1,982	
Josephine	3,567	− 2,428	4	258	
Lane	26	− 8,621			
Union	1	+ 1			
Malheur-Wallowa		− 2,145			
Total	50,684	−60,014	1,842	183,403	10,500
Average value per ton of ore	$12.85	+ $4.14			

The total tonnage, by kinds of ore sold or treated, in each county in Oregon in 1908 is shown in the following table:

Subdivision of tonnage of ore sold or treated in Oregon in 1908, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Total.
Baker	38,413		38,413
Coos	3		3
Curry	10		10
Douglas	120		120
Grant	5,251		5,251
Jackson	3,293		3,293
Josephine	1,435	2,132	3,567
Lane	26		26
Union		1	1
Total	48,551	2,133	50,684
Increase (+) or decrease (−)	−55,087	−4,927	−60.014
Average value per ton in gold and silver	$12.49	$2.82	$12.08
Average recovered value per ton, all metals	$12.50	$20.78	$12.85

The following table gives the number of mines, classified according to their chief product, in the counties of Oregon in 1908:

Number of mines classified by chief product in Oregon in 1908, by counties.

County.	Non-producing mines.	Gold placer mines.					Deep mines.				Total mines reporting product.
		Hydraulic.	Drift.	Dredging.	Sluicing.	Total.	Gold.	Silver.	Copper.	Total.	
Baker	142	13	1		15	29	21			21	50
Benton					1	1					1
Coos	7				12	12	1			1	13
Curry	12	3			8	11	1			1	12
Douglas	18	10			5	15	2			2	17
Grant	61	7	2		7	16	11			11	27
Harney	6				2	2					2
Jackson	43	17		1	8	26	10			10	36
Josephine	70	29	2		14	45	17		1	18	63
Lane	40						1			1	1
Malheur	12	6			2	8					8
Umatilla					3	3					3
Union	2				1	1			1	1	2
Wallowa	4				1	1					1
Wheeler	2				3	3					3
	419	85	5	1	82	173	64		2	66	239

PRODUCTION BY COUNTIES.

BAKER COUNTY.

Mine production of gold and silver in Baker County, Oreg., in 1907 and 1908.

Year.	Gold.		Silver.		Total.
	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		
1907	30,526.80	$631,045	69,589	$45,929	$676,974
1908	24,571.06	507,929	17,495	9,273	517,202
Decrease (−)	−5,955.74	−123,116	−52,094	−36,656	−159,772

Baker has always been by far the most productive county in Oregon, but the returns from producers in 1908 showed a material reduction in output. The yield of gold, valued at $507,929, in 1908 was $123,116 less in value than the production of 1907. The silver product, 17,495 fine ounces, was 52,094 ounces less than the output in 1907. There were 50 producing mines in the county in 1908, as compared with 46 in 1907. The placers numbered 29, of which 13 were hydraulic, 1 was a drift mine, and 15 were sluicing mines. The total number of deep mines from which product was reported was 21, and their output was 38,413 tons of siliceous ore in 1908, which was 31,468 tons less than in 1907, though the number of producing mines was the same in both years. The gold yield of this ore was valued at $469,532, and the silver yield was 17,086 fine ounces, valued at $9,056. The average value per ton was $12.22 in gold, as compared with $8.15 in 1907, and 24 cents in silver, as compared with 65 cents in 1907. From the 38,413 tons of siliceous ore there were derived 1,636 tons of concentrates, valued at $175,477 in gold and silver. The average value of these concentrates was $107.26 per ton. The placer mines of the county yielded $38,397 in gold in 1908, as compared with $61,754 in 1907.

Baker City district.—The mines in Baker and Virtue districts are considered as included in this district, the number of producing mines being only 4 deep mines and 5 placers. The deep mines are those of the Aurora Gold Mining Company and the Virtue Mines Development Company, the P. F. Ray mine, and the Oregon Fitzgerald mine; and the placers are the Gold Nest, the mines of the Stices Gulch Gold Mining Company, the Mon Kee, Wing Hing Yuen, and a group of smaller properties. The value of the total output of the district for 1908 was $22,113. The placer yield was $15,616 in gold and $69 in silver. The deep mines produced 662 tons of ore, which yielded $6,374 in gold and $54 in silver.

The Oregon Fitzgerald mine at Baker City is equipped with a mill of small capacity which was only operated one month. There are several tunnels on the property of a combined length of 1,200 feet, the longest being 500 feet. The Aurora Gold Mining Company (Carpenter Hill) has a 5-stamp mill. The Virtue Mines Development Company has a 20-stamp mill. The mine was worked only a few months, as the operators devoted most of the year to installing new machinery, rebuilding the mill, and changing over to electric power; and old dumps only were worked in the mill. The United Elkhorn

Mines, the largest producing property in 1907, were idle during 1908. The Western Exploration and Dredge Company was not in operation during the year. The Highland Gold Mining Company operated its mine during the year, but made no output, development work only being done. The Timber Canyon Mines Company put up a 5-stamp mill in 1908, but it was not operated until after the close of the year. The Dan Gold Mining Company has a 20-stamp mill with concentrators, but work in the mine has thus far been confined to sinking shaft and running 3 tunnels, respectively 450 feet, 600 feet, and 700 feet long. Owing to various causes, mainly the idleness of the Elkhorn Company, the district produced $41,823 less in 1908 than in 1907.

Cracker Creek district.—This district includes the mines at Bourne and Sumpter—2 deep mines and 4 placers—the total value of whose output in 1908 was $213,589. The largest tonnage of the county came from this district in 1908, the quantity being 23,929 tons. This ore yielded $205,349 in gold and $5,390 in silver. The placer gold yield was valued at $2,836 and the placer silver at $14. The total gold yield of the district was therefore $208,185 and the total silver yield $5,404. At Bourne the Eastern Oregon Mining Company was the largest producer. The property has a 20-stamp plate-amalgamation mill with concentrators, and a cyanide plant for treatment of tailings. Both mill and mine were closed down at the end of August, 1908, pending arrangements for further development work. This shut down was after a continuous run from June, 1896, the total production during that period having been 158,917 tons of ore, yielding 100,045.04 ounces of gold and 103,616 ounces of silver, giving net returns after deducting freight and treatment charges of $2,022,705. The mine has considerable unexplored ground to the north, and lower levels are reported to show good ore, these lower levels only being accessible through a neighboring mine. The largest producer at Sumpter is the property of the Columbia Gold Mining Company, which is provided with a 100-ton concentrating plant and a 100-ton tailing plant. The shipping ore and concentrates are sold to the Tacoma smelter. The shaft on this property is 918 feet deep, and the 3 tunnels have an aggregate length of 1,935 feet. The total drifts in the property aggregate 17,134 feet in length. The Climax group of mines at Bourne made no output in 1908, work being confined to development in opening up ore bodies. A Pelton wheel and a small crusher have been installed to handle the richer ores until a modern machinery equipment is provided. Several large properties at Bourne, formerly productive, were idle in 1908. The small proportion of recovery of values in treatment in the ores was discouraging. Some of these are expected to resume operations before long. The Bishop Auburn placers at Bourne, and the Buck Gulch, Davis, and others produced in 1908.

Cornucopia district.—The total production from this district in 1908 was from 2 mines only, 1 deep mine and 1 placer. The Cornucopia mines of Oregon at Cornucopia were operated intermittently during the year, or about half the time. The property is developed by a tunnel 1,800 feet long and by incline shafts sunk from this main tunnel. The mine has a 20-stamp mill with 12 concentrating tables. The Elk Creek Mining Company made no output during the year. The property was under bond to the Emmett Mining Company, of Baker City, which has been developing it through a 600-foot crosscut.

The Norway mine has a 625-foot tunnel, and from this tunnel crosscuts have been run. A Huntington mill on this mine was not operated in 1908. The Queen of the West Mines Company has a 10-stamp mill with 7 concentrators, but only development work was done during part of the year. The Boulder and Uncle Jim was the only placer which made a yield in the district in 1908.

Rye Valley and Mormon Basin districts.—These two sections are so close together as virtually to comprise one district. There are only 2 placers and 1 deep mine to be considered. The placers are the Deer Creek and the Rye Valley mines, both hydraulic mines. The deep mine is that of the Commercial Mining Company, at Mormon Basin; it has a 10-stamp mill in operation. The company is quite an extensive producer. The value of the entire output for the district, both quartz and placer, aggregated $126,472.

Other districts.—At Bridgeport there are but 2 producing mines, the Surprise quartz mine and the placer mine of the Clark Creek Mining Company. In Cable Cove district the Imperial Mining and Development Company, operating a deep mine, was the only producer. It is equipped with a 60-ton concentrating mill for base ore. There are about 9,000 feet of underground workings, about 1,000 feet of which were run during the development work in 1908. The 4 placers and 1 deep mine at Connor Creek yielded a total of $12,208 for the year. The Connor Creek Mining and Milling Company has a 20-stamp mill with concentrators. Only 10 stamps were operated for three months in 1908, though development work was carried on in the mine during the entire year. The hydraulic mine of the Huntington Mining Company was worked by Chinese during 1908. The operators of the Cincinnati mine, at Durkee, were preparing to put in a 10-stamp mill. The Conquest mine is equipped with a 10-stamp mill, but it was not operated in 1908. The Gold Coin was at one time worked as a quartz mine, but is now being opened for hydraulic work by putting in 14 miles of ditch, 2 reservoirs, 1,000 feet of flume, and 1 mile of 24-inch inverted siphon pipe. The New Century mine was worked, but made no yield, and this was also the case with the property of the Idaho-Oregon Mining Company. At Geiser there is only 1 productive deep mine and 1 placer. At Greenhorn are 4 deep mines which are productive, the Draper, Golden Gate and Chloride, Royal White, and Tempest. None of these are equipped with reduction plants. The operators expect better shipping facilities by an extension of the Sumpter Valley Railroad to Thomas's ranch, 7 miles distant. The general outlook of the district in 1908 was not good. Very little development work was done, and many of the lesser properties were given up entirely. At Hereford, or Pine Creek, there was 1 productive hydraulic mine, that of the Burnt River Consolidated Mining and Dredging Company. At Homestead, or Iron Dyke, the Grey Eagle deep mine made a production, as did the Jones placer. The 50-ton smelter of the Iron Dyke Copper Mining Company remained closed down during 1908. Small placer yields were reported from Richland and Sparta. At Sanger 1 lode mine reported a small output, and at Vincent there was production from 1 lode and 1 placer mine. At Weatherby there is 1 placer mine and 1 lode mine, the latter, the Weatherby Bonanza, with a 5-stamp mill. At Vincent Creek are 2 productive mines, one a deep mine and the other a placer.

BENTON COUNTY.

In Benton County production was reported from only 1 small placer at Corvallis.

COOS AND CURRY COUNTIES.

There were 2 small productive quartz mines in Coos and Curry counties, 1 in each. The Salmon Mountain Coarse Gold Mining Company operated at Eckley, Coos County, and the Higgins mine was worked at Selma, Curry County. The value of the total yield of Coos County was $1,674. The small placer mines are located near Bullard and Eckley. The total yield of Curry County was $8,918, a large part of which came from the single quartz mine. The placer producers are at Sanger, Gold Beach, Illahe, Marial, and Port Orford. There are also some small beach mines at the mouth of Sixes River.

DOUGLAS COUNTY.

The production of Douglas County showed a total output valued at $19,232 from 2 deep mines and 15 placers in 1908. The tonnage was very small and was derived from the mines of the Glendale Mining Company, at Glendale, and the Hall mine, at Nugget. The placers yielded $15,715 in gold and 201 ounces in silver. The producing placers were those of Booth & Eleff, Curtis Brothers, Miser & O'Shea, South Extension, and Gold Leaf, at Booth; Douglas, at Glendale; Byron Gulch and Red Bell, at Olalla; Copper Creek, and Texas and Thornton Gulch, at Perdue; Ash, Crackerjack, and others, at Riddles. The hydraulic mines of the county yielded $14,385 in gold, and the other placers $1,330.

GRANT AND HARNEY COUNTIES.

In 1908 Grant County produced 4,287.77 fine ounces of gold, valued at $88,636; 17,987 ounces of silver, valued at $9,533; and 503 pounds of copper, valued at $67, the total value being $98,236. This was within a few hundred dollars of the output in 1907. It may be noted that Grant produced more silver than any other county in the State, the quantity being slightly larger than that of Baker. There were 5,251 tons of ore derived from the deep mines, yielding gold valued at $65,755; 17,364 ounces of silver, valued at $9,203; and 503 pounds of copper, worth $67. The placer gold was valued at $22,881. The deep-mine producers were the Oregon-Idaho Investment Company and the Buffalo Monitor Mining Company, at Granite; the Equity Copper and Gold Mining Company, the Ironside, and the Present Need Gold Mining Company, at Prairie City; the Red Boy Mines Company, at Red Boy; the Compton Mining Company and the Empire, Monarch, and Ophir mines, at Susanville. Of the ore, 4,808 tons were treated at gold and silver mills, yielding $39,091 in gold and $572 in silver. Of ore shipped to smelter there were 443 tons, yielding $21,589 in gold and $8,041 in silver. The yield from 141 tons of concentrates was $5,075 in gold and $590 in silver. The Buffalo Monitor mine, at Granite, supplies smelting ore to both the Tacoma and the Sumpter smelters. Mining conditions were quiet at Granite

during the year. Lessees operating the Phoenix-Golden Eagle mine began milling a good grade of ore in 1909. The Equity Copper and Gold Mining Company, at Prairie City, has a 5-stamp mill and concentrators and ships its concentrates to the Tacoma smelter. The Ironside mine, at Prairie City, was operated only a few months in 1908. The Red Boy Mines Company has a 20-stamp mill and 50-ton cyanide plant, but the output was not large, most of the time being occupied in development work. The mine has a 200-foot vertical shaft and 5,000 feet of tunnel. About 1,500 feet of development work was done. At Susanville, the Empire and Monarch mines are equipped with custom mills. The ore of the Ophir mine is sent to the smelter at Tacoma. The producing placers in Grant County are at Austin, Beach Creek, Canyon City, Galena, Granite, Prairie City, and Susanville. The most productive of these is the Clark hydraulic mine, at Canyon City. The hydraulic mines of the county yielded $17,422, and the other placers $5,459. The St. Anthony Consolidated Gold Mining Company, at Granite, made no output, but during the year ran several hundred feet of tunnel, put in a railroad track and trestle, and put in order and leased a 10-stamp mill. The operators of the Salt Lake group, at Granite, performed development work during six months of the year.

The Jupiter mine, at John Day, with a 20-stamp mill, was shut down in 1907 and remained idle in 1908. The Standard Consolidated mines, at Prairie City, equipped with a 100-ton mill, made no output in 1908, but some drifting and development were done. The Northwestern Gold and Copper Mining Company operated seven months of the year, but made no output. In Grant County, Granite district yielded $31,751 from 4 placers and 2 deep mines. Canyon City district produced $15,522 from 5 placers. Quartzburg district yielded $12,907 from 2 placers and 3 deep mines. The most productive district was that at Susanville, where 5 deep mines and 1 placer produced $34,434 in gold and silver.

In Harney County there were but 2 producers in 1908, both placers, at Bourne and at Harney. The total value of the yield of the county was $910.

JACKSON COUNTY.

In 1908 Jackson County produced 3,237.88 fine ounces of gold, valued at $66,933, and 1,354 ounces of silver, valued at $718. In 1907 the county produced $181,647, the decrease of output for 1908 being $113,996. There were 36 mines producing in 1908, of which 10 were deep, 17 hydraulic, 1 dredge, and 8 sluicing properties. Reports were received from 43 nonproducing mines. The tonnage of ore was 3,293 short tons, which was 11,630 tons less than in 1907. This tonnage yielded 720.30 fine ounces of gold, valued at $14,890, and 585 ounces of silver, valued at $310. All this ore was treated at gold and silver mills, yielding $12,955 in gold and $263 in silver on the plates. The 60 tons of concentrates from the ore yielded $1,935 in gold and 89 ounces of silver. The placers in 1908 produced $52,043, of which $14,462 came from hydraulic mines and the balance from other forms of placer mining. The district yields for all kinds of mining in the year were as follows: Applegate, $4,562, from 4 deep and 3 placer mines; Foots Creek, $35,318, from 11 placers,

including 1 dredge; Galls Creek, $6,808, from 1 placer and 3 deep mines; Sardine Creek, $6,732, from 1 placer and 2 deep mines; and Evans Creek and branches, $11,452, from 3 placers.

The deep mines are all at Applegate, Gold Hill, and Jacksonville. The Afterthought mine, at Applegate, is a small producer, from which ore is hauled 3 miles to a custom mill. The Brush Creek mine is equipped with a 4-stamp prospecting mill, which was operated for three months during the year. The Maid of the Mist mine was operated only during the last half of the year 1908; its ore was treated at a custom mill. The 5-stamp mill of the Star mine was operated on test runs only in March and April, but the mine was worked the entire year. The operators of the Bill Nye mine, at Gold Hill-Galls Creek district, treated a small quantity of dump ore in a 5-stamp mill. The Braden mine made a small production. The Corporal G and Volunteer mines were worked about six months only, and most of the work was development. The Lucky Bart mines are equipped with a 5-stamp mill with concentrator. The Tin Pan mine has a 10-stamp mill, but the property was closed down in August, 1908. The Golconda and Victor mines, at Ashland, were under development. The Montreal and Oregon Gold Mining Company built a 10-stamp mill with concentrators in 1908, but lack of water prevented more than experimental operations and retimbering the old tunnels and inclines. The Shorty Hope Mining and Milling Company continued development, but did not operate its 10-stamp mill. The operators of the C. S. mine, at Gold Hill, ran 1,300 feet of tunnel. Some ore was taken out by the Last Chance Gold Mining Company, but none of it was milled. Little work was done in the Little Giant mine during the year. The Star Gold Mining Company performed development work. The producing placers in the county in 1908 were at Applegate, Ashland, Central Point, Draper, Gold Hill, Jacksonville, and Medford. Placers are also worked at Rock Point and Sams Valley, in Foots Creek district; at Weimer, in the Sykes Creek district, and at Woodsville and Gold Hill. The largest producer was the Champlin Dredging Company, at Gold Hill. Among the others, those which had a notable production were the Electric Gold Dredging Company, operating a hydraulic mine at Central Point; the Black Gold Channel Mining Company and Lance Brothers, at Foots Creek, and the Lone Star mine, at Woodsville, in the Pleasant Creek district.

JOSEPHINE AND LANE COUNTIES.

The total output of Josephine County in 1908 was valued at $194,139, as compared with $261,723 in 1907, a decrease of $67,584 for 1908. Of the total production in 1908, the gold was 7,387.93 fine ounces, valued at $152,722; the silver was 6,007 ounces, valued at $3,184; and the copper was 289,645 pounds, valued at $38,233. There were 63 mines reporting product in 1908, which is the largest number in any county of Oregon. Of these, 18 were deep mines and 45 were placers. The latter comprised 29 hydraulic, 2 drift, and 14 sluicing properties. Reports were also received from 70 nonproducing mines in the county. The total amount of ore treated in Josephine County in 1908 was 3,567 tons, yielding $36,134 in gold and 2,343 ounces in silver. There were 1,418 tons of ore milled, yielding $26,238 in gold and $1,042 in silver. The 2,149 tons of ore smelted

yielded $9,643 in gold and $195 in silver. The placer gold product was 5,639.94 fine ounces, valued at $116,588, and 3,664 ounces of silver, valued at $1,942. The falling off in tonnage in 1908, as compared with that of 1907, was 2,428 tons.

Althouse and Sucker Creek districts, with 11 placers and 3 deep mines, produced $7,732 in 1908. The yield from 3 placers and 3 deep mines in Applegate Creek and tributaries was $16,842. Four placers and 3 deep mines at Galice made an output of $23,580. At Grave Creek 3 placers and 3 deep mines produced $49,010. Two placers on Silver Creek yielded $2,148. At Waldo 3 placers and 1 deep mine produced $59,507.

On Wolf Creek 2 deep and 3 placer mines yielded $7,122. Of the deep productive mines the Gipsy Queen at Brownstown is equipped with a small prospecting mill, and development work was carried on for six months of the year. The Mountain Lion at Davidson is equipped with a 5-stamp mill with concentrators but was operated only two months in the year. The operators of the Little Anaconda at Golden milled only one or two months of the year. The Oaks Consolidated Mining Company made only a small output. The Martha Mining Company at Greenback has a 5-stamp mill, but the mine was only operated for half the time in 1908. At the January mine at Holland the ore is treated in an arrastre. The Trevor Mines Company at Holland put up a small prospecting mill in 1908 and did considerable development work. The Pinal mine at Kerby is equipped with only an arrastre for the treatment of its ore. The Hammersley mine at Placer is equipped with a 5-stamp mill, but was worked only part of the year. The Takilma Smelting Company at Takilma has a 100-ton matte smelter (blast furnace). The matte was sold to the Tacoma smelter.

The placers of Josephine County yielded $116,588, as against $36,134 gold from the deep mines. Five small placers were producing in 1908 at Brownstown, 3 of which are hydraulic. There was a small placer production at Davidson. At Galice 4 placers were in operation, the most productive being the Old Channel Mining Company. At Golden the Ruble hydraulic mine was operated. At Grants Pass the Jump Off Joe, Cook & Howland, Sexton, and Oscar Creek mines were worked. At Holland a number of small mines were producing.

The Canyon Creek and the Josephine placers, and the mines of the Illinois Gold Mining Company, and Wilson & Anderson, all hydraulic mines, were in operation at Kerby. The Crackerjack and McNair Flat hydraulic yielded production at Leland. The Flanagan & Emerson mine, the mines of the Hells Gate Mining and Development Company, and of the Northwest Mines Company, all hydraulic mines, operated at Merlin. The property of the Columbus Mines Company and the Red Hill hydraulic mines were worked at Placer. The Horsehead hydraulic mine, at Provolt; the McGuire hydraulic mine, at Selma; the Allen Gulch mine, the mine of the Deep Gravel Mining Company, the Logan, and the Cameron & Simmons hydraulic mines, at Waldo; the Payne mine and the Vindicator Mining Company's hydraulic mines, at Wolf Creek, all yielded notable amounts of placer gold.

Among the nonproductive mines in Josephine County in 1908, the Gray Back, at Kerby, ran a tunnel to open the vein; tunnel work

was also done at the Lotus and Little Edelweiss, and ditches were dug at the Josephine and Klamath hydraulic mine, at Brownstown post-office. On the Jupiter No. 1 placer three months were occupied in development work. The Alameda Consolidated Mines Company, at Galice, did 3,000 feet of underground work in 1908 and later installed a 100-ton matting furnace. The Argo Mining Company has a 16-ton rotary ball mill, but did not operate it in 1908. The operators of the Black Jack group, the Hohman-Toskett mine, the Richmond and Forty-Five mine, the Strenuous Teddy mine, the Marshall mine, and the Spotted Fawn group, the latter at Golden, did development work only. The Granite Hill, Red Jacket, and Ida mines (formerly the property of the American Gold Fields Company) are equipped with a 20-stamp plate-amalgamation and concentrating mill which was idle during the year, though development work was done. The operators of the Tough Nut mine, at Greenback, milled no ore in 1908. The Gold Bar Mining Company, at Holland, did development work only. The Evening Star mine and the Telluride Gold Mining Company, of Kerby, carried on active development. The Copper Standard Mining Company, at Merlin, stored ore on the dump until ready to ship to a smelter or build a smelter. The Oro Fino Mining Company, at Grants Pass, continued driving its tunnel. The Mountain Treasure Mining Company completed a water-power plant to drive the air compressor, the air being taken to the mine in a 2,800-foot pipe line from Jump Off Joe Creek.

In Lane County there was only 1 deep producing mine, the property of the West Coast Mines Company, in the Bohemia district. The 20-stamp mill with concentrating machinery was operated only a short time, though development work was carried on during the year. The Great Western Company was developing preparatory to milling. The Combination mine, in Bohemia district, was in the development stage, as was the property of the Grouse Mountain Mining and Milling Company. The Grizzly Mountain mine was worked during part of the year. The Mayflower Mining Company during the year built a 100-ton reduction plant, consisting of Chile roller mills, concentrators, and cyanide tanks. The Twin Rocks Mining Company carried on development work for several months of the year. The Noonday mine, at Cottage Grove, is equipped with a 20-stamp mill with concentrators, but it was not operated in 1908.

MALHEUR COUNTY.

Malheur County in 1908 produced $14,750 from 8 placers, no production being reported from deep mines. Of these placers, 6 were hydraulic mines and 2 were sluicing properties. The value of the output from the county in 1908 was $4,464 less than in 1907. The producing mines are all at Malheur, in the Mormon Basin district.

The Daisy Mining Company, at Malheur, has a Bryan roller mill and a Johnston concentrator. The Golden Eagle Mining Company has 3 small stamps and a concentrator. A lower tunnel has been started to cut the vein in the shaft. The Red, White, and Blue Mining Company has a 6-stamp mill, with concentrator, and is sinking on the vein.

UNION, WALLOWA, AND WHEELER COUNTIES.

Union County made a production in 1908 valued at $442 from 2 small mines. The nominal production in Wallowa County was from a small property. In Wheeler County 3 placers at Mitchell yielded $1,019.

SOUTH DAKOTA.

By Charles W. Henderson.

PRODUCTION.

For the calendar year 1908 the mine operators of South Dakota reported to the United States Geological Survey a production of gold, silver, and lead valued at $7,790,188, an increase of $3,590,028 over the production of 1907. The output of gold, the principal metallic product, was 370,425.58 fine ounces, valued at $7,657,376, an increase of 170,240.69 fine ounces, valued at $3,519,187. A proportionate increase in silver was shown, the production of that metal for 1908 being 248,762 fine ounces, as compared with 93,895 fine ounces in 1907, an increase of 131,844 fine ounces. The lead production amounted to 23,046 pounds in 1908. There was no production in 1907.

The number of producing mines was 5 less than in 1907, only 19 operators reporting in 1908, but an increased production was noted from each mine which made an output.

The total ore mined in 1908 amounted to 1,929,549 short tons, with an average value in gold and silver of $4.04 per ton, as compared with 1,471,156 short tons, averaging $2.85 per ton, in 1907. This increase in value per ton was caused largely by an increase in the value saved per ton from the Homestake ore.

Mine production of gold, silver, and lead in South Dakota in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) and decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	200,184.89	$4,138,189	370,425.58	$7,657,376	+170,240.69	+$3,519,187
Silver.....do....	93,895	61,971	248,762	131,844	+154,867	+ 69,873
Lead.....pounds..	(a)	(a)	23,046	968	+ 23,046	+ 968
	.....	4,200,160	.....	7,790,188	.....	+ 3,590,028

a None reported.

The monetary difficulties of the early part of the year and the decline in the prices of silver and the base metals did not affect the gold mines in the Black Hills. The regular producers were operated steadily, and several large properties entered the producing stage for the first time, with the result shown in the table—a largely increased production. The adoption of the eight-hour day somewhat increased the price of labor, but the extended use of electricity effected considerable saving in running expenses. The Homestake Mining Company enjoyed an unusually prosperous year and was the most important producer of the State. The discovery of ore in the lower quartzite by

the Imperial Company bids fair to give an increased impetus to the district. The problem of successfully treating the "blue" (or unoxidized) ores, running from $5 to $7 per ton, which generally fail to yield to the cyanide process an extraction of more than 30 to 40 per cent and are too low in value to ship, has received considerable attention. Renewed efforts have been made to obtain a better extraction by the use of variations of the cyanide process. Some very promising results have been obtained, but nothing has reached a commercial basis. Roasting makes much of this ore amenable to treatment, but is considered too costly for practical work. The increased use of slime processes in the Black Hills is very marked. With the mills now building there will be in operation 4 Moore plants, 1 Merrill sluice-filter press plant, 1 closed-type filter press plant, 2 decantation plants, 1 Burnt press, 1 Chamberlain press, and 1 Butters plant.

Source of gold and silver production in South Dakota in 1908.

Source.	Number of mines.	Tonnage.	Gold.		Silver.		Total value.
			Quantity.	Value.	Quantity.	Value.	
Deep mines:		*Short tons.*	*Fine ounces.*		*Fine ounces.*		
Siliceous ore	19	1,929,513	369,932.10	$7,647,175	245,083	$129,894	$7,777,069
Lead ore		36	12.53	259	3,500	1,855	2,114
	.....	1,929,549	369,944.63	7,647,434	248,583	131,749	7,779,183
Placer mines	8	.....	480.95	9,942	179	95	10,037
	27	1,929,549	370,425.58	7,657,376	248,762	131,844	7,789,220

CUSTER COUNTY.

Two operators reported an increased output in 1908 over that of the one producer in 1907. The total for the county can not be given without disclosing individual productions, and Custer County is again tabulated with Pennington County.

The Blue Bell group was worked during two months of the year and the ore was treated in the 10-ton plant on the ground. The Saginaw Gold Mining and Milling Company, of Custer, deepened its shaft and ran 325 feet of drifts. A 10-stamp (copper) plate-amalgamation mill, with concentrating tables, and a 50-ton cyanide and slime plant were completed in 1908 and operated for a short time. The Granite Reef owners spent the year in development of the property and in experiments on the ore, with the expectation of erecting a plant. The Ideal Mining Company was actively engaged in preparing to enter the producing list in 1909. Development work, in driving 300 feet of tunnel and sinking a shaft on the Bessie lode, was continuous throughout the year. An 80-ton Chilean mill will be completed in the spring of 1909. The Empire-Baker Company, with two 100-foot double-compartment incline shafts, sunk in 1907, continued its development work. The Hartwell Mining Company and the White Cloud Mining Company reported development.

LAWRENCE COUNTY.

Mine production of gold, silver, and lead in Lawrence County, S. Dak., in 1907 and 1908, in fine ounces.

Year.	Gold.		Silver.		Lead.		Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1907	200,014.52	$4,134,667	93,830	$61,928	.....	.....	$4,196,595
1908	370,094.05	7,650,523	248,686	131,804	23,046	$968	7,783,295
Increase (+)..	+170,079.53	+3,515,856	+154,856	+69,876	+23,046	+968	+3,586,700

All but $6,893 of the production of $7,790,188 of South Dakota came from Lawrence County. The increase of this county was 457,690 tons of ore, $3,515,856 in gold, and 154,856 fine ounces of silver.

There were 1,927,808 tons of siliceous ore produced from 13 deep mines in 1908, with an average value per ton in gold and silver of $4.03, as compared with 19 mines in 1907, with an output of 1,470,154 tons, and an average value per ton of $2.85. Of the tonnage of 1908, 1,921,134 tons were treated on the ground in gold and silver mills, and yielded to the amalgamating plates and cyanide treatment $7,509,588 in gold and 232,623 fine ounces of silver, a total of $7,632,878, at an average value per ton in gold and silver of $3.97. To smelters outside the State were sent 6,696 tons, valued at $130,404, at an average value in gold and silver of $19.47 per ton. A small amount of gold and silver was recovered from slag.

The increase in tonnage is due to an increase in production of every property, and the average tenor of the ore is affected directly by the increased value in the Homestake. Several properties showed a decrease in the value of the ore, but the majority showed an increase. Four placer mines showed a decided increase in production, the principal producer being the Golden Placer Company, at Central City.

During 1908 the use of electricity was extended so that the only steam power is now at the Homestake, and this company used electricity in three of its stamp mills, the slime plant, and the regrinding plant. Both the Consolidated Power and Light Company, with a steam plant, and the Black Hills Traction Company, with water development, are loaded to the maximum and are planning to increase their capacity. It is probable that the summer of 1909 will see a new water-power plant commenced on Spearfish Creek that will add from 5,000 to 7,000 horsepower to the present power in use.

The Homestake Company operated continuously its 6 stamp mills, aggregating in number 1,000 stamps, and nearly doubled its production of 1907. The secondary treatment plant consists of 2 cyanide sand plants, of a monthly capacity of 75,000 tons, and 1 cyanide slime plant, with a capacity of 50,000 tons monthly. During 1908 a new reservoir of large capacity was added, and the foundry was rebuilt and equipped with modern machinery. A regrinding plant, consisting of 6 grinding pans and a 5 by 14 tube mill, to handle the coarsest sands from the batteries, was installed. The reground pulp passes over plates before going to the cyanide mills. In mine development depths of 1,700 feet were reached in the Ellison shaft, and of

1,250 feet in the Star shaft. Four other shafts range to 800 feet in depth. The tunnels, drifts, and crosscuts aggregate 50 miles of workings.

The mills of the Golden Reward, Imperial, Lundberg, Dorr & Wilson, Mogul, Portland, Reliance, and Wasp No. 2 properties, in the Whitewood district, operated steadily in 1908. The Golden Reward Company's mill is a 200-ton wet-crushing cyanide plant. Early in the year, a Chamberlain press for handling slimes was installed, and at the close of the year, the installation of the Moore process was ordered. The tonnage of 1909 will probably show a further increase over that of 1908. The deepest shaft on the property is down 587 feet. There are five other shafts of various depths. The prospecting operations of the Imperial Gold Mining and Milling Company in 1908 may be of great importance to the Black Hills. The Dakota shaft was sunk to 600 feet, where the lower quartzite was encountered and some ore found. Several hundred feet of drifts were run in the quartzite. Should ore be found in the quartzite in quantities similar to that found in the shale above, the life of the district would be appreciably prolonged. The company has a 100-ton cyanide plant. The Lundberg, Dorr & Wilson mill, a 100-ton cyanide plant with a 6-foot Chilian mill, was operated continuously on custom ore and ore from the company's Buxton and Bonanza properties. The mines were worked continuously during the year. Both mines are developed by tunnels. The remodeled mill of the Mogul Mining Company treated over 320 tons per day, and reached a maximum of 388 tons. A tube mill and the Moore process for treating the slimes were installed. The Portland Mining Company shipped its ore to the Lundberg, Dorr & Wilson mill, at Terry, and to the Globe plant of the American Smelting and Refining Company, in Denver. The company is prospecting on the lower, or quartzite, contact. In 1908 the Reliance Gold Mining Company, in the Bald Mountain district, drove 1,200 feet of tunnel. The plant consists of 4 Huntington mills and 1 cyanide plant. The Wasp No. 2 Mining Company increased its tonnage considerably in 1908. The ore is mined from open cuts, and milled in a 200-ton dry-crushing plant. The ore treated is of very low grade.

The New Iron Hill Mining Company, in the Whitewood district, shipped ore with values in gold, silver, and lead to Denver.

In the Bear Butte district the Gilt Edge-Maid Gold Mining Company at Turner, working a very large body of low-grade porphyry, and crushing to $\frac{3}{16}$-inch mesh, was reported as having established a record for the Black Hills for low cost of mining and milling. The Golden Crest Mining Company, also mining in porphyry near the Gilt Edge-Maid, was building a 200-ton mill to crush with stamps, regrind with tube-mill, and treat the whole product by the Moore process. This is the first company in the Black Hills to erect an all-sliming plant.

In the Maitland (or Garden City) district, the Minnesota Mines Company completed a 100-ton cyanide mill early in the year, and ran steadily from June to December, inclusive. Considerable development work was done. The ore bodies lie in two formations—one vertical and one flat, and are opened up by a shaft of 165 feet in depth, and 2 tunnels. In the same district the North Homestake Mining Company, after a year's idleness, due to the strike and to the change from steam to electric power, started in March, 1908, and ran

successfully the remainder of the year. The capacity of the plant, which is a wet-crushing (cyanide) stamp mill, is 150 tons.

There were several important companies which did not produce in 1908. The Branch Mint Operating Company, which leases the 120-stamp mill of the Branch Mint Company, expects to work on an old dump, while the mine is being opened. The Hercules Gold Mining Company, of Galena, began work on a 200-ton cyanide plant (40 stamps) at the close of the year, after spending the year on development of the mine. The Lucky Strike Gold Mining Company spent the year in development and in completing a 150-ton stamp mill with a cyanide plant. The Safe Investment Mining Company, in the Germania district, with a 405-foot shaft, 2,000 feet of tunnels, and 500 feet of drifting on the 400-foot level, in development work, has a 40-stamp mill with concentrators, and a cyanide annex, the total capacity of which is 200 tons in twenty-four hours. The American Eagle Mining Company, with a 200-ton mill, closed down. The Ama-Queene Gold Mining Company, near Albany, reported development.

PENNINGTON COUNTY.

Both the placer and the deep mines of Pennington County increased production considerably in 1908 over that of 1907.

At Hill City the Canton Mining Company's property was operated from January to April. The workings on the mine consist mainly of a 200-foot incline shaft, with drifts on the vein. The milling plant is a 24-ton Chilian mill, with plates and concentrator. The Cumberland Mining and Milling Company, in the same district, operated its 10-stamp mill for a time during the year. The Continental Copper Mining and Smelting Company, near Hill City, installed machinery, and continued active development work in sinking shafts, running adit tunnels, and operating diamond drills. The workings now consist of a 550-foot shaft and 2 adit tunnels, the principal one 1,160 feet long. The Gopher Mining Company reported development.

The Keystone mines were in the development stage in 1908. Among the operating companies were the Bullion Gold Mining and Milling Company, the Heyland Group, the Lisbon property, the Lucky Boy, the North Fork Gold Mining and Milling Company, and the United Mining Company. The last reported equipment in the form of a 20-stamp concentration mill, a cyanide mill, and a 15-stamp concentration mill on the Keystone-Holy Terror claims.

The Mystic district also was the scene of much development in 1908. The Mariposa Gold Mining and Milling Company's developments on the Mariposa claim aggregate 1,600 feet. The Gold Bug claim of this company has a shaft 200 feet deep. The Hymalulu Company, on Slate Creek, spent the year in development and building a plant. The deposit is reported to be a fissure vein of unusual width. The developments aggregate about 600 feet. The old stamp mill of the Cuttysark and Basil mines, which had been destroyed by fire, was replaced in 1908 by a standard 10-stamp mill with Wilfley tables. The Auburn Gold Mining Company has completed 600 feet of tunnel work on its property.

At Oreville, the Forest City Mining Company took over the Clara Belle property and performed development work. A 10-stamp mill and a cyanide plant are on the property.

The Harvest Mining Company, on Rapid Creek, near Pactola, performed development work.

Near Rochford, in the Hornblende district, the North Star Mining Company completed its Chilian mill, with amalgamating plates, and made a short run before the close of the year. The ore was extracted from open cuts and shallow shafts. The Stanby Mining Company, of Rochford, reconstructed 20 stamps of its old mill for the purpose of making tests on the ore. The mine development now consists of a vertical shaft of 400 feet and a tunnel 1,600 feet long. The Gordelia Mining Company was idle the entire year. Prospecting below the oxide zone was pursued by the Golden West Mining Company. The company's Chilian mill has a capacity of 50 tons daily on oxidized ore. The Balkan Mining and Milling Company built a 5-stamp amalgamating mill for its free-milling ore.

A short run was made by the Rockerville Gulch placer, in the Tepee district, near Rockerville. The McCurdy placer at Pactola was worked in a small way in 1908. There was a little placer gold taken out in the vicinity of Keystone.

TEXAS.

By H. D. McCaskey.

PRODUCTION.

The following table shows the production of gold, silver, copper, lead, and zinc in Texas in 1907 and 1908:

Mine production of gold, silver, and associated metals in Texas in 1907 and 1908.

Year.	Gold.		Silver.		Copper		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Lbs.*		*Lbs.*		*Lbs.*		
1907	0.435	$9	303,688	$200,434			23,947	$1,269	44,000	$2,596	$204,308
1908			444,336	235,498	28,364	$3,744	65,833	2,765	35,957	1,690	243,697
Increase (+) or decrease (−)	−.435	−9	+140,648	+35,064	+28,364	+3,744	+41,886	+1,496	−8,043	−906	+39,389

In 1908 the production of precious metals and of copper, lead, and zinc, in Texas, showed, on the whole, a marked increase over that of 1907. The production of gold is mainly the small amount annually recovered in the refining of silver from the Shafter mine, or from copper ores. There was none reported from the mines in Texas in 1908. The production of silver in 1908 was 444,336 fine ounces, valued at $235,498, an increase of 140,648 fine ounces in quantity and of $35,064 in value over that of 1907. No copper was reported in 1907, but in 1908 there were produced 28,364 pounds, valued at $3,744. The lead production was 65,833 pounds, valued at $2,765, an increase of 41,886 pounds in quantity and of $1,496 in value; and the zinc output was 35,957 pounds, valued at $1,690, a decrease of 8,043 pounds in quantity and of $906 in value, as compared with that of 1907. The value of the total production of

the five metals was $243,697, an increase of $39,389 over the value of the production of 1907.

There were 15 or 20 nonproducing mines and prospects of these metals in 1908, and 5 producers. The total tonnage milled or shipped was 21,823 short tons, of which 139 tons was copper ore, 79 tons was zinc ore, and 15 tons was lead ore, the remainder being dry ores. All of the silver, except 109 ounces from lead ores, was reported in 1908 from the dry ores.

The average value per ton in precious metals from dry ores (including tailings) was $10.90. This was from recovered silver alone in 1908, and showed an increased value per ton of $0.68 over the recovered values for 1907. All of the copper and zinc reported came from El Paso County, and nearly all the silver and lead from Presidio County, mainly from the Shafter mine.

In Archer, Baylor, Jones, Montague, Stonewall, and other counties in northern Texas copper has long been known in blue clays in the Permian.[a] Some prospecting has been done; at one time considerable shipments were made to Baltimore and Philadelphia, and a smelter was even built in Hardeman County for treating these ores, but there has been no output for many years. The copper-bearing beds are said to average 4 feet in thickness and to assay from 1 to 8 per cent of copper for the whole thickness; but transportation and other difficulties have proved discouraging in past efforts to make these deposits pay. In the northern part of Brewster County, near Alpine, are the Bird mines, from which some silver-bearing galena has been shipped to the El Paso smelter, according to Phillips.[b] In the northwestern part of Burnet County, in central Texas, lead ore is reported by Phillips[c] in quantity thought to warrant thorough prospecting. This deposit is on Silver Creek and is described as a contact deposit of galena in greensand and limestone, presumably of Silurian age, on the upper contact of coarse-grained granite. In Blanco and other counties are reported similar deposits of galena. In Burnet, Blanco, Gillespie, Llano, and Mason counties, all in central Texas, are quartz fissure veins, in granite intrusive in pre-Cambrian gneiss, which carry copper ores.[d] The surface ores are carbonates of copper, and argentiferous tetrahedrite, bornite, chalcocite, and chalcopyrite are reported in depth. There were at one time many workings, particularly in the Babyhead district in Llano County, but the deposits seem never to have proved anything more than good prospects.

It is undoubtedly in trans-Pecos, or western Texas, that the most inviting deposits of silver, copper, lead, and zinc have so far been found. The region has been late in mineral development, and the reasons most commonly assigned for this in the past have been lack of water, relatively high price of mineral lands held by the State, and difficulty on the part of miners in distinguishing state lands from railroad and other land grants.[e] In addition to the

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[a] Cummins, W. F., Notes on the geology of northwest Texas: Fourth Ann. Rept. Geol. Survey Texas, 1893, pp. 232–238.

[b] Phillips, W. B., Lead ore in Burnet County, Tex.: Eng. and Min. Jour., vol. 77, 1904, p. 364.

[c] Phillips, W. B., op. cit., p. 364.

[d] Comstock, T. B., Report on the geology and mineral resources of the central region of Texas: Second Ann. Rept. Geol. Survey Texas, 1891, pp. 577–582. Also, A preliminary report on the geology of the central mineral region of Texas: First Ann. Rept. Geol. Survey Texas, 1890, pp. 334–339.

[e] Phillips, W. B., The Texas mineral lands and the mining law: Bull. Univ. Texas Mineral Survey No. 6, 1903, pp. 16–34.

Bird mine of Brewster County, mentioned above, are the now well-known quicksilver deposits of the Terlingua district, near the Mexican border; and in the Franklin Mountains near El Paso, in the northwestern portion of El Paso County, are tin deposits associated with quartz veins in granite.[a] It is in El Paso County, however, in the Guadalupe, Quitman, Carrizo, Sierra Diablo, Van Horn, Eagle, Wiley, and other mountains that the largest number of copper, lead, and zinc prospects have so far been found; and in Presidio County, to the southeast, is the Shafter mine, the most important silver-lead producer of the State. In the Quitman Mountains, near the Mexican line, the Bonanza and Alice Ray mines produced silver-lead-zinc ores of good grade a number of years ago, but the product seems not to have been welcomed by the smelters.[b] The Hazel mine, in pre-Cambrian sandstone,[c] at the southern foot of the Sierra Diablo range, near Allamore, also produced in the past an important output of silver-copper ores.[d] Near by are the Sancho Panza and Don Quixote prospects, from which copper ore to the value of $10,000 is reported to have been shipped.[e] In the Guadalupe Mountains, just south of the New Mexico line, copper deposits in the Permian beds are reported. There was a small production of copper from this region in 1908 by the Calumet and Texas Mining Company, but the ores are thought to be of too low a grade to warrant shipment at present prices of copper. The Little Lightning mine, near Sierra Blanca, also produced a small quantity of copper, in 1908, and F. V. McKinney, operating in the same district, reported a small production of silver and lead. Farther to the east, near Boracho, the Beck prospect produced zinc ores which were shipped in 1908 to Gas, Kans. The operators of the Davis and Robinson zinc mines, in the Eagle Mountains near Torbert, made important shipments of ore carrying 40 per cent of zinc to Gas, Kans., in 1907; but there was no production reported from these properties in 1908. The ores are calamine and smithsonite in Carboniferous sediments. Coal is known to occur a few miles to the south, and the Eagle Springs district, in which these ore bodies lie, would seem to be one of promise. In Presidio County there was an important production of silver and lead, mainly from the Shafter mine, which has been operating almost steadily since 1884. The mine is now developed by 2 vertical shafts, 400 and 700 feet deep, and by several miles of underground workings, of which 1,200 feet of drifts, crosscuts, and other development was done in 1908. The plant includes a 15-stamp mill in which the pan-amalgamation process is used. The ores at present mined are the oxidized products of argentiferous galena and occur in a Carboniferous limestone to which Udden has given the name Cibolo limestone.[f] Other mines of the district are the Chinati, Humphrey, and Ellsworth mines, none of which made any production in 1908.

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[a] Weed, W. H., Tin deposits at El Paso, Tex.: Bull. U. S. Geol. Survey No. 213, 1903, pp. 99–102. Richardson, G. B., El Paso folio (No. 166), Geol. Atlas U. S., U. S. Geol. Survey, 1909, pp. 9–10.

[b] Von Streeruwitz, W., Geology of trans-Pecos, Texas: First Ann. Rept. Geol. Survey Texas, 1890, pp. 223–224.

[c] Richardson, G. B., Reconnaissance of trans-Pecos, Texas: Bull. Univ. Texas Mineral Survey No. 9, 1904, pp. 24–25.

[d] Von Streeruwitz, W., trans-Pecos, Texas: Third Ann. Rept. Geol. Survey Texas, 1892, pp. 387–389.

[e] Von Streeruwitz, W. H., Report on the geology and mineral resources of trans-Pecos, Texas: Second Ann. Rept. Geol. Survey Texas, 1891, p. 699.

[f] Udden, J. A., The geology of the Shafter silver mine district, Presidio County, Tex.: Bull. Univ. Texas Mineral Survey No. 8, 1904, p. 54.

UTAH.

By V. C. Heikes.

PRODUCTION.

The total value of the production of gold, silver, copper, lead, and zinc in Utah for the year 1908, as reported by 182 producers, including 6 placers, amounted to $23,441,280. Copper constituted nearly half the value, Utah having produced 86,843,812 pounds of that metal in 1908, with a commercial value of $11,463,383; and yet, although the quantity of copper produced was one-third greater than in 1907, the lower average price in 1908 decreased its total value $1,387,994. Silver was second in value, the output of 8,451,338 fine ounces calculated at the average commercial price amounting to $4,479,209. Silver ranked first up to 1905. The quantity of silver produced is largely dependent on the tonnage of lead ores mined, which contained in 1908 two-thirds of the silver, or 5,570,548 fine ounces. Lead, which was third in value, amounted to $3,728,655. It usually equals the silver in total value. Gold was fourth, amounting to $3,701,387 in value in 1908, the lowest total since 1902. Zinc has been reported each year since 1904 not to exceed $400,000 in value in any one year. The production in 1908 was valued at $68,646, limited to concentrate from the Park City region and sulphide ore mined in Beaver County.

The statement of production for 1907 and 1908, showing increases and decreases and valued at each year's commercial prices, is as follows:

Mine production of gold, silver, and associated metals in Utah in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	247,759.63	$5,121,646	179,054.60	$3,701,387	− 68,705.03	−$1,420,259
Silver.....do....	10,990,076	7,253,450	8,451,338	4,479,209	− 2,538,738	− 2,774,241
Copper.....pounds..	64,256,884	12,851,377	86,843,812	11,463,383	+22,586,928	− 1,387,994
Lead.....do....	115,938,037	6,144,716	88,777,498	3,728,655	−27,160,539	− 2,416,061
Zinc.....do....	5,452,916	321,722	1,460,554	68,646	− 3,992,362	− 253,076
	.....	31,692,911	.....	23,441,280	.....	− 8,251,631

Utah's production of ore and its content for five years are as follows:

Total tons of ore sold or treated in Utah in 1904–1908, and total content of gold, silver, and associated metals.

Year.	Tonnage.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1904.....	1,716,947	202,675.00	12,049,446	46,417,234	116,479,764	73,439	$21,989,415
1905.....	2,181,061	248,692.00	11,036,471	57,298,054	103,882,009	3,330,327	25,824,387
1906.....	2,348,819	252,439.43	11,550,634	56,593,576	125,342,836	6,474,615	31,419,365
1907.....	2,669,696	247,759.63	10,990,076	64,256,884	115,938,037	5,452,916	31,692,911
1908.....	3,658,957	179,054.60	8,451,338	86,843,812	88,777,498	1,460,554	23,441,280

[a] Includes the very small placer production.

Utah had 6 of its smelting establishments operating in 1908, two of them the entire year. Three of these were lead plants and 3 were equipped for copper smelting. All of the smelters do a custom business, besides smelting ores from properties owned by the same interests. Two of the smelters treating lead ores are situated near Salt Lake City, the other at Silver City, and the copper plants are at Garfield, Bingham, and Ogden. The greater part of the ores treated was produced in Utah; the next largest quantity came from Nevada and Montana, with less from California and Colorado; a small percentage mined in Utah was shipped to the two latter States. Smelting establishments treated about one-fourth of the ores mined and shipped in 1908, or 786,038 tons, valued for the gold, silver, copper, lead, and zinc at $13,017,931, a total average value per ton of $16.56. In addition, there were resmelted 591 tons of old slag. Two-thirds of the combined output of crude ore and concentrate shipped to smelters was the product of 163 producers who sold ore to custom smelters in 1908. The two products sold aggregated 630,514 tons and contained 67,202.17 ounces of gold, 5,413,217 ounces of silver, 77,142,978 pounds of copper, and 71,856,315 pounds of lead, the total value being $17,459,035, an average of $27.69 per ton. The remainder of the crude ore and concentrate treated at smelters was handled by establishments connected with mines. Concentration of ores was carried on in 19 mills situated in 7 counties, as follows: Salt Lake, 6; Summit and Wasatch, 5, including the operation of 2 tailing plants on Silver Creek in Summit County; Tooele, 5, including 2 jigging plants; Beaver, 1; Sevier, 1; and Utah, 1. The tonnage of ores treated at concentration mills in 1908, representing two-thirds of the quantity mined in Utah, aggregated 2,522,734 tons, and, as compared with 1907, was over one-half greater in quantity; the concentrates produced amounted to 184,052 tons, and were about one-third more than in 1907, the ratio of concentration being 13.7 into 1, or 5 points higher than in 1907. The concentrates were valued at $9,434,631 for the gold, silver, copper, lead, and zinc, and averaged $51.26 in value per ton. Eighty-five per cent of the milling ores was mined at Bingham, the next greatest quantity at Newhouse, in Beaver County. About one-eighth of the total value of the gold and silver output in Utah was bullion, which contained the two metals and was produced at milling plants. Three of these plants used amalgamation, and 4, including 1 tailing plant, used the cyanide process for the treatment of 313,845 tons of ore, valued at $960,134, an average yield per ton of $3.06 in gold and silver. The quantity of gold and silver ore treated in 1908, as compared with that of 1907, was 50,825 tons greater and was valued at $74,355 more.

ORE PRODUCTION, 1908.

The ore mined in Utah amounted to 3,658,957 short tons, containing gold, silver, copper, lead, and zinc, and having an average value of $6.40 per ton. The tonnage was increased about one-third over that reported in 1907, and was lowered in average value $5.47, mainly through the increased tonnage of low-grade porphyry ores mined for copper at Bingham, in Salt Lake County. This continues to be the principal source of this low-grade ore, which, with the Newhouse ore deposits in Beaver County, represented 64 per cent of

the ore output of Utah. West Mountain district (Bingham) held the record for 1908 of shipping the greatest tonnage of crude ore to smelters; it shipped 68.7 per cent of the total, and 85.2 per cent of the total of ores to concentrating mills. Dry siliceous ores, with their principal value in gold, were produced in greatest quantity in Tooele County; copper and copper-lead ores in Salt Lake County; and lead and lead-zinc ores in Summit and Wasatch counties. Zinc ores, owing to the low price of spelter, showed the largest decrease. The total tonnage, by kinds of ore sold or treated, in each county of Utah during 1908 is shown in the following table:

Subdivision of tonnage, by kinds, of ore sold or treated from Utah in 1908, by counties, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver, Emery, Iron, Piute, and Sevier [a]	21,457	215,448	5,987	99	1,386	.....	244,377
Boxelder, Cache, Morgan, and Washington	103	16,190	77	.....	.....	.....	16,370
Grand, Garfield, San Juan, and Uinta	.....	6	.....	.....	.....	.....	6
Juab	3,021	111,194	28,346	.....	24	.....	142,585
Salt Lake	2,412	2,633,592	56,779	.....	5,154	.....	2,697,937
Summit and Wasatch	.....	.....	140,331	.....	.....	2,000	142,331
Tooele	325,281	.....	56,563	.....	170	.....	382,014
Utah	.....	3	33,334	.....	.....	.....	33,337
Total	352,274	2,976,433	321,417	99	6,734	2,000	3,658,957
Value per ton in gold and silver.	$3.03	$1.24	$10.47	$5.86	$7.05	$2.65	$2.23

[a] No production in 1907.

In 1907 the subdivision of the tonnage and the average per ton in gold and silver were as follows: Siliceous ore, 280,561 tons, $3.36 per ton; copper ore, 1,793,084 tons, $3.09 per ton; lead ore, 575,880 tons, $10.02 per ton; zinc ore, 12,251 tons, $1.78 per ton; copper-lead ore, 2,920 tons, $13.48 per ton; lead-zinc ore, 5,000 tons, $2.89 per ton.

ORE DEPOSITS.

Ore is mined in Utah from three classes of deposits: (1) Disseminated ores in monzonite porphyry or allied rocks; (2) replacement deposits in limestone more or less clearly connected with fissures; (3) fissure veins.

In 1908 the monzonite porphyry deposits had the largest yields in tonnage and quantity of copper and represented 64 per cent of the ore and 63 per cent of the copper, about 10 per cent of the gold, and 2 per cent of the silver of the output of Utah. Nearly all the monzonite ores were milled and produced largely chalcocite, chalcopyrite, and bornite in the concentrates. Some of the richer ore, containing the same minerals, was shipped direct to the smelter from Bingham, in Salt Lake County, and Newhouse, in Beaver County.

Replacement ore bodies in limestone yielded the largest quantities of gold and silver, nearly all the lead, and all of the zinc. The tonnage of ore was 35 per cent of the Utah total, and yielded 86 per cent of the gold, 95 per cent of the silver, 36 per cent of the copper, and 91 per cent of the lead. The ores mined from these deposits

were largely of shipping grade, there being only 477,563 tons milled out of 1,270,371 tons from deposits in limestone. Of the quantity milled a little over one-third was concentrated and the remainder was cyanided. Mines in the Tintic district and in the Park City region yielded from replacement deposits mostly siliceous and carbonate ores, which contained the greater part of the gold and silver. The West Mountain (Bingham) district ranked next in importance of production of gold and silver, and exceeded the other districts in copper, which, with the lead and silver, was derived largely from sulphide ores. Practically all of the ores were from the three districts mentioned. Other districts which produced in 1908 from limestone deposits were American Fork, in Utah County; Star and Bradshaw, in Beaver County; Little and Big Cottonwood, in Salt Lake County; Clifton, Rush Valley, Ophir, North Tintic, Silver Islet, and Camp Floyd, in Tooele County; and Fish Springs, in Juab County. The Mercur ores in Camp Floyd district, of Tooele County, are included in this classification, as the ores are entirely in siliceous limestone along porphyry sheets.

Fissure veins cutting all kinds of rock produced approximately 1 per cent of the ore, 4 per cent of the gold, 3 per cent of the silver, three-fourths of 1 per cent of the copper, and about 9 per cent of the lead. The yield of gold and silver came principally from fissures in the Tertiary volcanic flows in Gold Springs and Stateline districts in Iron County and from Gold Mountain district in Piute County. These districts yielded most of the gold and silver from this source; fissure veins in the Tintic district, of Juab County, produced some of the silver and all of the lead and copper credited to fissures in that district. Fissures in sandstone in San Juan and Grand counties yielded a small quantity of copper in 1908, and the Silver Reef sandstone deposit in Washington County produced a small quantity of silver. Fissures in granite in Park Valley district, of Boxelder County, yielded gold and silver. The ores also contain very small quantities of lead, which is saved by concentration.

GOLD.

The gold produced in 1908 aggregated 179,054.60 fine ounces, valued at $3,701,387. Compared with the figures of 1907 this was a decrease of 27.8 per cent, the decrease being general in all the producing counties of Utah. The placers yielded a small quantity, but showed a small increase over the output of 1907, and were reported principally from San Juan and Garfield counties, where operations are carried on mainly by the use of burlap tables, with which it is possible to save a fair percentage of the value from the sand and gravel. A dredge, capable of treating 1,500 yards of gravel daily, was completed in October on Green River, in Uinta County, but too late, it is stated, for much more than limbering up the machinery before zero weather set in. No production was reported for the short time this dredge was in operation. It is reported that the roadways are being prepared on the Colorado River, in Garfield County, for hauling material for the construction of a dredge near Hite.

Sixty-two per cent of the gold produced in Utah was contained in 786,038 tons of crude ore shipped to smelters and yielding $2,300,674

in gold, an average of $2.93 per ton. From 2,522,734 tons of ore treated at concentration mills, 184,052 tons of concentrate were saved, containing $437,851 in gold, an average of $2.38 per ton. At mills equipped with the cyanide or amalgamation processes, 313,845 tons of ore yielded $950,244 from bullion produced, an average of $3.03 per ton of ore treated. The leading gold producers, those yielding over 10,000 ounces in 1908, named in order of importance, were the Centennial-Eureka, in Juab County; the Mercur mine, in Tooele County; and the Utah Consolidated and the Utah Copper mines, in Salt Lake County. Of the total quantity of gold produced in Utah two-thirds was derived from copper ores and 11.2 per cent from lead ores. The siliceous ores furnished 26.5 per cent of the total gold produced in 2 districts, Camp Floyd (Mercur), in Tooele County, and Gold Mountain (Kimberly), in Piute County. These two regions are the most important, since they have always held first place for siliceous gold ores.

Source of gold production of Utah, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver, Emery, Iron, Piute, and Sevier[a]	.....	4,354.61	1,846.58	307.09	1.35	4.50	.....	6,514.13
Boxelder, Cache, Morgan, and Washington	.....	145.03	4.50	.24	.....	.....	.....	149.77
Grand, Garfield, San Juan, and Uinta	440.69	.....	.....	.....	.....	.....	.....	440.69
Juab	.....	580.96	53,729.63	4,367.50	.....	1.08	.....	58,679.17
Salt Lake	.....	615.26	55,496.78	4,683.82	.....	76.77	.....	60,872.63
Summit and Wasatch	.....	.....	.....	5,072.58	.....	.....	10.76	5,083.34
Tooele	.....	41,743.29	.....	218.85	.....	7.82	.....	41,969.96
Utah	.....	.....	8.63	5,336.28	.....	.....	.....	5,344.91
	440.69	47,439.15	111,086.12	19,986.36	1.35	90.17	10.76	179,054.60

[a] No production in 1907.

SILVER.

The yield of silver amounted to 8,451,338 ounces, valued at its average price for the year of 53 cents per ounce, at $4,479,209. Compared with the figures of 1907, the output decreased nearly one-fourth in quantity and $2,774,241 in value. The Tintic district, in Juab and Utah counties, continues to yield the greatest quantity of silver, followed by the Park City region, which lies in Summit and Wasatch counties. The two districts mentioned produced over three-fourths of the state total, or 6,582,175 ounces, derived mainly from lead ores. The only place where silver alone has been produced in the past is from the Silver Reef sandstone formation.[a] The occurrence is near Leeds, in the Harrisburg district, Washington County, where the metal is contained in the sandstone as chloride of silver, which is associated with and often replaces plant remains. The chloride of silver is readily amenable to amalgamation and a 5-stamp mill in that region continues to be operated a short time each year, yielding some silver bullion.

[a] Emmons, S. F., Copper in Red Beds of Colorado Plateau: Bull. U. S. Geol. Survey No. 260, 1904, p. 228.

Mines in Utah producing over 500,000 ounces of silver in 1908, named in order of output, were the Centennial-Eureka, in Juab County; the Silver King, in Summit County; the Colorado, in Utah County; and the Daly West, in Summit County. The crude ore treated at smelters, 786,038 tons in quantity, yielded 7,148,583 ounces of silver, averaging 9.09 ounces per ton. The total yield of silver from crude smelting ore was about one-fourth less in 1908 than in 1907, and the average per ton, which was 7.75 ounces in 1907, was 1.34 ounces greater in 1908. At concentration mills 184,052 tons of concentrate were made, yielding 1,273,583 ounces of silver, an average of 6.92 ounces per ton; the total quantity of silver was less than in 1907 by nearly one-third and in average per ton by 5.52 ounces. The silver extracted from ore at cyanide and amalgamation mills, at which 313,845 tons of ore were treated, yielding 18,662 ounces, averaged 0.059 ounce per ton. Silver from lead ores aggregated 5,570,548 ounces, which was two-thirds of the state total; the output was 1,729,462 ounces less than the production of 1907, and was largely accounted for in Juab County, where several of the mines discontinued the shipment of lead ore during the time smelters were closed or in course of construction. For a like reason, in the same county, silver contained in copper ores would have decreased had not the Centennial-Eureka Company, which mines a siliceous copper ore, been able to ship its product to a smelter outside of Utah.

Source of silver production of Utah, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver, Emery, Iron, Piute, and Sevier[a]	.....	14,102	36,099	90,397	1,044	22,744	.....	164,386
Boxelder, Cache, Millard,[a] Morgan, and Washington	.....	3,522	4,308	859	.....	.....	.....	8,689
Grand, Garfield, San Juan, and Uinta	63	.....	611	.....	.....	.....	.....	674
Juab	.....	79,569	1,874,146	793,667	.....	907	.....	2,748,289
Salt Lake	.....	44,445	704,358	329,276	.....	47,130	.....	1,125,209
Summit and Wasatch	.....	.....	.....	2,454,149	.....	.....	9,586	2,463,735
Tooele	.....	21,647	.....	341,375	.....	15,351	.....	378,373
Utah	.....	.....	1,158	1,560,825	.....	.....	.....	1,561,983
	63	163,285	2,620,680	5,570,548	1,044	86,132	9,586	8,451,338

[a] No production in 1907.

COPPER.

The output of copper in 1908 amounted to 86,843,812 pounds, valued at $11,463,383. Compared with the figures of 1907, this was an increase in quantity of 27.7 per cent, but on account of the lower average price of 13.2 cents per pound, the value decreased $1,387,994. There were decreases in all counties except Boxelder, Salt Lake, and Tooele. Bingham, or West Mountain district, which is in Salt Lake County, produced in 1908 nearly one-third more copper than in 1907. By the smoke injunction of the court, all copper furnaces near Salt Lake City were closed entirely, and this had much to do with reducing the copper production. Transportation facilities for handling the large tonnage of ore from the mines at Bingham to the mills were not in perfect condition, but better service was in force

the latter part of 1908. Then, too, the product of the great mills was curtailed to some extent by the restricted operation of the Garfield smelter, where there was difficulty for a time in reducing the concentrate in the reverberatory furnaces. It is understood that all the difficulties have been met at the smelter, which is handling 2,800 tons of ore per day. With the entire completion of the two great concentration mills of the Utah Copper and the Boston Consolidated, at Garfield, in addition to the operation of the mill of the former company at Copperton, and the beginning of the operations of the Ohio Copper mill, at Bingham, the year 1909 should see the figures of the copper output pass the 100,000,000-pound mark. Mines in Utah producing during 1908 over 1,000,000 pounds of copper each, named in order of output, were the Utah Copper, the Utah Consolidated, and the Boston Consolidated, at Bingham, in Salt Lake County; the Cactus mine, in Beaver County; the Yampa, at Bingham, in Salt Lake County; the Centennial-Eureka, at Eureka, in Juab County; and the Copper Mountain mine, in Lucin district, Boxelder County. Two of these properties in Salt Lake County are equipped with steam shovels and the ore, which is a low-grade porphyry, averaging less than 2 per cent in copper, is mined at a small cost per ton. Low-grade porphyry ores are mined at Newhouse, in Beaver County, and at Bingham, in Salt Lake County, the total production combined making 2,335,641 tons, or over two-thirds of the total ore mined in Utah. All of the ore, with the exception of 95,095 tons, which was smelted, was milled, and produced 121,046 tons of concentrate (a ratio of 18.5 tons of ore into 1 of concentrate), consisting principally of chalcocite, chalcopyrite, and some bornite, and yielding 53,411,303 pounds of copper, an average of 441.25 pounds per ton, equivalent to 22 per cent. Smelting plants handled 786,038 tons of crude ore, the largest part of which was lead ore. The copper from smelting ore was 31,948,303 pounds, principally from sulphides, which yielded an average of 2.03 per cent. Concentrates containing copper produced at the milling plants were of two kinds, those yielding copper in addition to gold and silver and those yielding copper with lead in addition to gold and silver. The copper concentrates, 121,046 tons, were the yield of 2,331,514 tons of ore, and the copper-lead concentrates, 53,245 tons, of 154,983 tons of ore. These two kinds of concentrates, aggregating 174,291 tons, contained a total of 54,821,552 pounds of copper and averaged 15.72 per cent of metal. The milling ores containing this copper were mined in the following districts: Little Cottonwood and West Mountain, Salt Lake County; Ophir, Tooele County; San Francisco, Beaver County; Snake Creek, Wasatch County; and Park City, Summit County. Compared with the figures of 1907, the total copper content of crude ore to smelters was one-fourth less, and in concentrates was about one and three-fourths greater in 1908.

LEAD.

In 25 mining districts lead was produced from ores which yielded 88,777,498 pounds, valued, at the average price for the year of 4.2 cents per pound, at $3,728,655. The output was nearly one-third less in quantity than in 1907 and $2,416,061 less in total value. The decrease is attributed to the lower price for the metal and the higher treatment rate imposed by the smelting companies, which had the

effect of closing many mines, except those having contracts with smelting companies permitting shipments at the old rates of treatment. The lead furnaces at Murray were operated the entire year, and in July the Bingham Junction lead smelter, which was closed earlier in the year by the smelter-smoke injunction of the court, resumed operations. Heavy decreases in lead production were made in each county of Utah during 1908, except in Summit and Wasatch, where the decrease was small. This section easily held first place with an output of 34,051,699 pounds in 1908. Lead contained in crude ore yielded at the smelters about three-fourths of the total output, or 64,494,107 pounds, which was nearly one-fifth less than the production from crude ore in 1907. From 62,602 tons of lead concentrates, separated from 191,220 tons of ore, there were produced 24,136,476 pounds of lead, which was over one-third less than the output made from Utah concentrates in 1907. About two-thirds of these concentrates had copper associated with the lead. The largest lead producers, those producing over 5,000,000 pounds each, named in order of output, were the Silver King, at Park City; the Colorado mine, in Tintic district; the Daly West and the Daly Judge, in the Park City region; the Old Jordan and the Telegraph, at Bingham. There were 15 others that produced each from 1,000,000 to 3,000,000 pounds of lead.

ZINC.

The zinc output for 1908 was less in quantity than a third of that for 1907. The production reported, reduced to terms of spelter, aggregated 1,460,554 pounds, valued at $68,646. Zinc ore and concentrate have not been profitably shipped from Utah when the metal is quoted below 5 cents per pound, and this was mainly the reason for decreased production. All the product is shipped to Colorado, Kansas, or points farther east. The buyers of ores rarely contract for sulphides containing zinc under 30 per cent, or for carbonates with a metal content below 20 per cent, and it is an advantage if they have copper, silver, and gold. New processes continue to be tried on Utah zinc ores to enrich the concentrates by the elimination of other minerals, which, in the form of galena and pyrite, accompanied by gold and silver, readily find a market at the smelters near Salt Lake. The Park City mill of the Graselli Chemical Company, of Cleveland, Ohio, using Sutton dry tables, dielectric separators, and dry-sizing apparatus, increased the capacity of its plant from the experimental arrangement to one which is daily treating an important tonnage of zinc middlings from the Daly Judge mill. Shipments of concentrate to its eastern refinery have aggregated nearly 100 tons per day.

MINING INDUSTRY OF UTAH IN 1908.

The mining industry suffered during 1908, being affected mainly by smelter troubles. The only smelting establishments in continuous operation were the Murray lead plant, of the American Smelting and Refining Company, and its copper plant at Garfield, but neither was at full capacity the entire year. Following the close of the Bingham Consolidated, United States, and Utah Consolidated smelters, a number of mining companies ceased shipments the early part of 1908. An advance in treatment charges on certain ore at

the smelters brought out many complaints from the miners, and for a time the smelters operating had barely ore enough to keep the furnaces in blast. Before the close of the year, however, rates were adjusted to meet existing conditions, and with better metal prices production again became normal.

According to the published annual statement made by the United States Smelting Company it handled 154,424 tons of charge during 1908. This was handled entirely in the lead plant, the copper plant being shut down under the injunction granted by the United States court of appeals. Since July, 1908, the lead plant has been reopened and operated under the modified decision with complete satisfaction. This has been accomplished by the construction of a building in which are hung 2,080 canvas bags, each about 18 inches in diameter and 33 feet long. These bags are protected tc a considerable extent by the use of a blower charged with zinc oxide, which gives a lining to each bag, thus protecting the bag from the acid fumes. The zinc oxide is converted to sulphate, and this, with the accumulated dust, is discharged twice a day and is said to contain approximately 30 per cent of lead and 20 per cent of arsenic. A petition has been filed in the district court of Utah asking permission to resume operations in the copper plant. The Yampa smelter, in Bingham Canyon, operates almost entirely on copper ores from the Yampa mine. It is equipped for handling 1,000 tons of ore daily, having 9 McDougall roasters, 3 blast furnaces, and 6 converters. Coke is shipped from Sunnyside, Utah, and limestone from Parley's Canyon. An experimental 100-ton smelting furnace was erected during 1908 near the Boston Consolidated mill at Garfield. The plant is known as the Fink smelter, and consists of 2 barrel-shaped receptacles capable of revolving at different speeds and in opposite directions. The fuel is blown into the first furnace and the flame is returned into the second furnace. While the charge in the first furnace is being smelted and refined, the charge in the second furnace is roasting, the heat being supplied from the gases escaping from the first furnace. The construction of the furnace allows a Bessemer smelting as well as a refining operation, and the crude ore charged into the furnace is converted into a finished product—blister copper. The furnaces are permanently prepared with a refractory lining. To be successful, such a plant must be operated continuously, a condition which is often difficult to meet where the ore supply is irregular. Its commercial success has not yet been demonstrated, this being the first large plant to be erected. At Silver City, in Juab County, the new Tintic smelter was not successfully operated until October, although it commenced business in August and turned out its first lead bullion on the 29th of that month. Before the close of the year 2 lead furnaces, of a capacity of 250 tons each, were operating, and a copper furnace was about ready to be placed in operation. The Utah Smelting Company, owning a copper furnace near Ogden, was succeeded by the Independent Smelting Company, which bought ores for a time. It is claimed that a discrimination in freight rates for the haul from copper camps in the vicinity of Salt Lake City brought business to a close. The plant closed in April, 1909. Near the end of 1908 a new concern, known as the "International Smelting Company," entered the Utah field and took possession of the smelter site located by the Utah Consolidated on the west side of the

Oquirrh Range, west from Bingham, near Tooele. It is reported that the new plant will be constructed to treat copper ores only and will have a capacity at starting of about 1,500 tons of ore daily. Except for the completion of the two large concentrating mills at Garfield and the work on the Ohio Copper mill, near Bingham, on the dry concentrator of the Graselli Chemical Company, near Park City, and on a 50-ton concentrator in Columbia district, of Tooele County, no other plants of importance were erected. Railroad construction on the narrow-gage line was completed in the Tintic district and put in operation between the various mines and the smelter.

Dividends aggregating $5,530,216 were paid by 12 producers in 1908. Seven of the producers were properties in the Tintic district, 3 were in Bingham district, 1 in Park City, and 1 at Fish Springs, in Juab County. Utah has 27 counties from 20 of which mine operators reported production of metal in 1908. Forty mining districts have a production credited to them for 1908. Later in this report a brief review is given of each of the productive counties and districts.

In the following tables is shown the output of gold, silver, copper, lead, and zinc for the year 1908, by counties:

Mine production of gold, silver, copper, lead, and zinc in Utah in 1908, by counties.

County.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Beaver, Emery, Iron, Piute, and Sevier	*Fine ounces.* 6,514.13	$134,659	*Fine ounces.* 164,386	$87,125	*Pounds.* 5,707,217	$753,353
Boxelder, Cache, Morgan, and Washington	149.77	3,096	8,689	4,605	2,305,681	304,350
Garfield, Grand, San Juan, and Uinta	440.69	9,110	674	357	799	106
Juab	58,679.17	1,213,006	2,748,289	1,456,593	5,704,360	752,975
Salt Lake	60,872.63	1,258,349	1,125,209	596,361	71,487,903	9,436,403
Summit and Wasatch	5,083.34	105,082	2,463,735	1,305,779	541,061	71,420
Tooele	41,969.96	867,596	378,373	200,538	1,067,292	140,882
Utah	5,344.91	110,489	1,561,983	827,851	29,499	3,894
	179,054.60	3,701,387	8,451,338	4,479,209	86,843,812	11,463,383

County.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
Beaver, Emery, Iron, Piute, and Sevier	*Pounds.* 3,103,950	$130,366	*Pounds.* 54,902	$2,580	$1,108,083
Boxelder, Cache, Morgan, and Washington	43,140	1,812			313,863
Garfield, Grand, San Juan, and Uinta					9,573
Juab	8,723,350	366,381			3,788,955
Salt Lake	15,773,844	662,502			11,953,615
Summit and Wasatch	34,051,699	1,430,171	1,405,652	66,066	2,978,518
Tooele	8,438,295	354,408			1,563,424
Utah	18,643,220	783,015			1,725,249
	88,777,498	3,728,655	1,460,554	68,646	23,441,280

Tonnage of ore sold or treated, number of producing mines, and tenor of ores in Utah in 1907 and 1908, by counties.

County.	Ore sold or treated (short tons).		Number of deep mines producing.		Average total value per ton.		Average value per ton in gold and silver.	
	1908.	Increase (+) or decrease (−).	1907.	1908.	1907.	1908.	1907.	1908.
Beaver, Emery, Iron, Piute, and Sevier	244,377	− 46,802	28	28	$6.92	$4.53	$2.01	$0.91
Boxelder, Cache, Morgan, and Washington	16,370	− 8,554	10	11	23.20	19.17	2.11	.47
Garfield, Grand, San Juan, and Uinta	6	− 205	3	2	14.17	71.66	12.29	54.00
Juab	142,585	− 99,843	41	37	28.86	26.57	19.07	18.72
Salt Lake	2,697,937	+1,174,959	40	47	8.94	4.43	1.99	.69
Summit and Wasatch	142,331	− 93,297	16	11	17.58	20.93	8.57	9.91
Tooele	382,014	+ 71,213	17	23	6.40	4.09	2.83	2.79
Utah	33,337	− 8,210	10	11	56.33	51.75	28.28	28.12
	3,658,957	+ 989,261	165	170	11.87	6.40	4.63	2.23

Tonnage of ore to gold and silver mills and concentrating mills, with amount of gold and silver contained in bullion produced in Utah in 1908, by counties.

County.	Ore to gold and silver mills.			Ore to concentrating mills.
	Quantity.	Gold in bullion.	Silver in bullion.	
	Short tons.		*Fine ounces.*	*Short tons.*
Beaver, Emery, Iron, Piute, and Sevier	21,411	$88,029	12,281	211,447
Boxelder, Cache, Morgan, and Washington	67	267	3,466	.....
Garfield, Grand, San Juan, and Uinta	.....	.....	.....	.....
Juab	70	56	2,839	.....
Salt Lake	.....	.....	.....	2,155,064
Summit and Wasatch	.....	.....	.....	105,260
Tooele	292,297	861,892	76	44,703
Utah	.....	.....	.....	6,260
	313,845	950,244	18,662	2,522,734

Mine production of gold, silver, and associated metals from Utah concentrates in 1908, by counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver, Emery, Iron, Piute, and Sevier	21,897	1,577.09	29,338	4,493,486	11,882	.....	$641,789
Boxelder, Cache, Morgan, and Washington	.....	.....	.....	.....	.....	.....	.....
Garfield, Grand, San Juan, and Uinta	.....	.....	.....	.....	.....	.....	.....
Juab	.....	.....	.....	.....	.....	.....	.....
Salt Lake	114,113	17,351.35	267,371	49,216,973	5,346,151	.....	7,221,569
Summit and Wasatch	28,214	1,868.68	718,772	169,337	14,891,835	1,405,652	1,133,454
Tooele	18,263	102.09	223,859	948,286	3,007,834	.....	372,258
Utah	1,565	281.86	34,243	.....	990,114	.....	65,561
	184,052	21,181.07	1,273,583	54,828,082	24,247,816	1,405,652	9,434,631

Mine production of gold, silver, copper, lead, and zinc from Utah crude ore shipped to smelters in 1908, by counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver, Emery, Iron, Piute, and Sevier	11,404	678.49	121,862	1,213,136	3,075,730	54,902	$370,508
Boxelder, Cache, Morgan, and Washington	16,303	136.84	5,223	2,305,681	43,140	.....	311,759
Garfield, Grand, San Juan, and Uinta	6	.....	611	799	.....	.....	430
Juab	142,515	58,676.47	2,745,450	5,704,360	8,723,350	.....	3,787,395
Salt Lake	542,441	43,352.63	848,986	22,207,863	10,426,681	.....	4,715,500
Summit and Wasatch	34,095	3,214.66	1,744,963	371,724	19,159,864	.....	1,845,064
Tooele	12,197	172.98	153,748	115,241	5,412,236	.....	327,587
Utah	27,077	5,063.05	1,527,740	29,499	17,653,106	.....	1,659,688
	786,038	111,295.12	7,148,583	31,948,303	64,494,107	54,902	13,017,931

Number of mines classified by chief products in Utah in 1908, by counties.

County.	Mines reporting product.	Gold placer mines, hydraulic.	Deep mines.							
			Gold.	Silver.	Gold and silver.	Gold, silver, and copper.	Gold, silver, copper, and lead.	Gold, silver, and lead.	Silver and lead.	Silver, lead, and zinc.
Beaver, Emery, Iron, Piute, and Sevier	28	.....	.....	.....	5	2	14	5	1	1
Boxelder, Cache, Morgan, and Washington	11	.....	.....	1	2	5	.....	1	2	.....
Garfield, Grand, San Juan, and Uinta	8	6	.....	.....	.....	2	.....	.....	.....	.....
Juab	37	.....	.....	.....	7	4	15	7	4	.....
Salt Lake	47	.....	.....	.....	1	7	32	7	.....	.....
Summit and Wasatch	11	.....	.....	.....	.....	.....	[a]6	3	.....	2
Tooele	23	.....	1	.....	3	.....	11	6	2	.....
Utah	11	.....	.....	.....	.....	1	6	4	.....	.....
	176	6	1	1	18	21	84	33	9	3

[a] One reported zinc also.

PRODUCTION BY COUNTIES.

BEAVER COUNTY.

The total production of gold, silver, copper, lead, and zinc in Beaver County in 1908, was valued at $1,012,319. With the exception of copper, all the other metals—gold, silver, lead, and zinc—made heavy decreases, and the total value was but half of that in 1907. The Cactus mine continued to be the only large producer of copper in the county, and made about its usual annual output. Greater activity in the Star districts and the exploration of some old lead properties, from which shipments were made, did much to keep the lead product in 1908 from decreasing more than a third in quantity of that produced in 1907. A plan to put the Majestic lead and copper smelter at Milford in operation again failed, as it did in 1907. There is some doubt as to the feasibility of making it a custom plant when freight rates and the price of fuel are considered.

Bradshaw district.—The Cave and Summit claims are being developed. Some oxidized iron ore, containing lead, gold, and silver, was shipped from the latter property in 1908. The lessees working in the Cave mine will begin shipping early in 1909. At the Hecla, work was continued in the development of a new ore body, which furnished an iron ore that averaged per ton about 1 ounce of gold and 12 ounces of silver and contained 15 per cent lead. The shipments in 1908 held well up to those made in 1907.

Lincoln district.—A shipment of silver-lead ore was made from the Harriet claims; also some lead sulphide ore came from the Lincoln mine.

Newton district.—From the Rob Roy property a trial shipment, consisting of high-grade gold quartz, was made.

Preuss district.—Development work in the 2,400-foot tunnel of the Indian Queen, and a shipment of sulphide ore containing silver and lead from the Galena group, constituted the activity in 1908.

San Francisco district.—This district, which has the camps of Frisco and Newhouse in its boundaries, had an output valued at $918,361 in gold, silver, copper, and lead. The two principal producers were the Horn Silver and the Cactus mines. The production of the Horn Silver was about half of that made in 1907. The annual statement to stockholders reported the shipment of 4,287 tons of lead carbonate ore and of 103 tons of copper ore. The total metal content consisted of 1,873,326 pounds of lead, 27,658 pounds of copper, 69,631 ounces of silver, and 185.48 ounces of gold. Zinc ore was not shipped, except a trial lot of 24 tons, which contained 13,061 pounds of that metal. A number of experimental tests were made by the company at plants in Salt Lake, Denver, and Texas on the low-grade ores; these tests were successful, but there remains the meeting of conditions under which the mill must be operated at Frisco. The Cactus mine, operated by the Newhouse Mines and Smelter Corporation, furnished about 800 tons daily of low-grade monzonite ore to the concentrating mill and a high-grade sulphide copper ore to the Garfield smelter. In the annual report of the corporation for the year ending June 30, 1908, the following statements are made: The company owns 12 patented claims, which contain 201 acres of mineral lands, and other property, including the Wah Wah springs and water system comprising 7,882 acres. The Wah Wah springs furnish a constant water supply of about 1,200 gallons per minute, which is collected in a reservoir and conveyed by gravity to the mill at Newhouse. The mine is opened by a main shaft 600 feet deep, from which are extended 6 levels, approximately 100 feet apart; the sixth level connects with the surface by means of a crosscut tunnel 6,016 feet long, through which all ore is passed to the crusher house. Below the 600-foot or adit level is an incline shaft following the dip of the vein sunk to a depth of 316 feet, from which are opened the seventh, eighth, and ninth levels. The development shows ore from the surface to a depth of 916 feet. The principal ore body extends for a length of 700 feet at the surface and varies in width from 90 to 174 feet; a second ore body has been opened for 140 feet, and shows a width of 100 feet. A total of 176,766 tons of ore were mined, of which all but 10,014 tons was milling ore. The mill produced 19,367 tons of concentrate. A total of 7,244,179 pounds of copper, 1,721 ounces of gold, and 38,595 ounces of silver

were produced. The copper production cost 7.05 cents per pound. The total cost, including freight, smelting, and refining, was 10.50 cents per pound.

Northeast of Newhouse a company developing the Golden Reef group reported an important body of galena in shale at a contact with porphyry in the tunnel 2,300 feet long driven on a gold quartz vein. This find is said to be on the north-south contact, 6 miles due north of the Horn Silver mine, and is creating considerable interest. West of the Horn Silver mine the King David Mining Company bought a large acreage in the limestone area on the Grampian Mountain. A shaft has been sunk to a depth of about 300 feet on a claim adjoining the Horn Silver. Next to these holdings are the claims of the Peacock Company in limestone, with a shaft 150 feet deep and a tunnel, which passed through stringers of lead sulphide and carbonate, with molybdate of lead associated. Considerable copper ore of low grade has also been found. The Cupric group, taking in the Washington claim, one of the oldest patents in the district, is developed with a shaft over 300 feet deep. Adjoining the Horn Silver on the south is the Lulu, where work was discontinued in 1907 and taken up again in September, 1908. The shaft is sunk 650 feet, which is equivalent to the Horn Silver 700 foot level. Drifting has been commenced to reach a point under the ore found in the winze on the 400-foot level.

The Frisco Contact property was closed down the entire year. To the northeast of this property the Beaver Carbonate mine was opened up in 1908 after years of idleness. The new shaft is 700 feet deep, and in December drifting from that level opened up a shoot of ore containing silver-bearing galena and said to be 75 feet long and 20 feet wide. Work on the old tailings dump was begun by the Utah Mining and Leasing Company, which is erecting a small mill. The Imperial mine in Lober Gulch, west of Frisco, was idle during 1908.

Star district.—Two districts, known locally as the North Star and the South Star, are situated southwest of Milford. Several old properties have developed into steady shippers of lead carbonate and sulphide ore during 1908. The Moscow mine has been the heaviest producer of lead ores to Salt Lake and of zinc ore to plants outside of Utah. A working shaft on this mine is sunk about 500 feet, at which level drifting encountered the ore body opened in the old workings in the upper levels. The Red Warrior claim, operated by a new company, is an old property, having been worked to a depth of 200 feet. The ore mined is an oxidized lead-silver product carrying an excess of iron and considerable lime. Development work was performed and some ore was shipped from other properties, including the Talisman, Cedar, Lydia, Hoosier Boy, Big Gentile, Progressive, Admiral Dewey, and Hub claims.

BOXELDER COUNTY.

Lucin district.—Several small shipments were made from this district, besides those made regularly from April to the close of 1908 by the Salt Lake Copper Company, operating the Copper Mountain mine. The property is reached from Tecoma, Nev., by 8 miles of wagon road. Ore is handled by a Leschen aerial tram from the mine to a spur of the Southern Pacific Railroad, and under a favorable contract with the Garfield smelter all the product went to those furnaces

in 1908. The mine is opened by numerous drifts, winzes, etc., aggregating 12,000 feet of work, part of which has now been stoped.

Park Valley district.—Operators of the Susannah property made a number of shipments of rich gold and silver ore to the smelters; but as the ore will yield its gold and silver and small quantities of lead and iron by amalgamation and concentration, a plant is being erected to be equipped with a 10-foot Lane mill and Pinder concentrator. Gasoline will be used for fuel. Mining is carried on through a 220-foot tunnel and by an incline shaft 60 feet deep, which reaches a depth of 120 feet from the surface. The Century mine is being developed, but there were no shipments of consequence in 1908. The mill was used in testing some ore produced by a neighboring property.

Sierra Madre district.—Development of the properties in this district continued with unabated activity. The veins thus far opened up are said to be large and well defined, but the ore is of low grade, consisting of copper and lead-silver minerals. A tramway has been constructed by one of the companies, which uses it at present for handling supplies. Preparations were made at the Eldorado property to begin work early in 1909.

CACHE COUNTY.

La Plata district.—South of Paradise, in this county, development of mining property has been carried on for several years, and a little ore was taken out for shipment. During 1908 the Silver King, a lead property, produced some ore which was shipped to a smelter near Salt Lake.

GARFIELD COUNTY.

Colorado River or White Canyon district.—A number of placer operations produced a little gold from the gravels up and down the river from Hite. The Good Hope Placer Company holds option on the Tickaboo Bar, and was said to be preparing the wagon road above Hite for the purpose of bringing in a dredge in 1909. The California Bar, Big Four, Olympia, and Red Canyon placers produced some gold in 1908.

GRAND COUNTY.

Grand River district.—In the vicinity of Professor Valley, near Grand River, the Mountaineer Placer Mining Company was developing and preparing the Red Hills and Island Bar placers for production. It has a sluicing plant installed, which is reported to handle 3 yards of gravel per hour.

La Sal district.—The Blue Chief Company operating the Blue Jay property, made one shipment of copper ore containing silver. Developments were made on the Clark, Clarendon, Finley, High Ore, and Boston and Utah properties. The Wilson Mesa, which covers an area 1,200 feet wide and 3 miles long, consisting of knolls and ridges, is remarkable in its production of gold found within certain boundaries, probably from the disintegration of the porphyry found within the area. Several operators reported gold recovered by sluicing methods. The average fineness of the gold is 0.867.

IRON COUNTY.

Near Gold Springs, the Jennie Gold Mining Company, whose plant is a cyanide mill with Nissen stamps, operated in 1908 and produced gold and silver bullion. In fineness the bullion ranged from 0.687 to 0.526 in silver and from 0.274 to 0.385 in gold. The Jennie Company has been retarded in its operations on account of the excessive cost of fuel, which condition will be remedied by an electric plant using producer gas as fuel. The site for the power plant is situated near Modena, about 10 miles southeast of the mine. Electric power will be supplied the Jennie, Uvada, Independence, and Snowflake properties. The Ophir mine, near Stateline, was operated by lessees who mined some gold and silver ore during the latter part of 1908, but owing to a heavy fall of snow shipments were delayed. The Holt property, operated by the Escalante Mining Company, was reported as having encountered at water level ore containing gold, silver, and lead.

JUAB COUNTY.

Fish Springs district.—Lead and silver ore continues to be the largest resource of the district, produced chiefly by the Utah mine, from which was shipped a larger and richer tonnage than in 1907. Shipments were also made from the Carnation No. 1 property, which is developed by a shaft 200 feet deep and drifts. The work in 1908 was principally to develop the claim, and no ore was taken from below the 100-foot level.

Mount Nebo district.—At the Eva mine the 300-foot level was extended for a distance of 100 feet, and ore was shipped assaying 25 per cent of lead and 20 ounces of silver per ton. The wagon road from the railway has been completed to within 1½ miles of the mine.

Tintic district.—The following table shows the metallic production of the Tintic district in 1907 and 1908:

Mine production of gold, silver, and associated metals in the Tintic district, Juab, and Utah counties, Utah, in 1907 and 1908, with increases and decreases.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	113,065.44	$2,337,270	63,248.58	$1,307,464	−49,816.86	−$1,029,806
Silver.....do....	4,949,082	3,266,393	4,118,440	2,182,773	− 830,642	− 1,083,620
Copper.....pounds..	7,755,831	1,551,166	5,707,786	753,427	−2,048,045	− 797,739
Lead.....do....	33,019,242	1,750,019	25,045,882	1,051,927	−7,973,360	− 698,092
	.....	8,904,848	.....	5,295,591	.....	− 3,609,257

This district extends into both Juab and Utah counties. The most important area, with 35 producers, lies in Juab County; and that portion in Utah County has 7 producers, there being a total of 42 producers reporting in 1908, or 2 more than in 1907. The metal output decreased in value from $8,904,848 in 1907 to $5,295,591 in 1908; the tonnage of ore mined from 278,504 tons to 172,582 tons; and the average value per ton from $31.97 to $30.70. With the exception of 6,260 tons of ore, valued at $65,561, for values saved

and the concentrates produced at the mills, the production was 166,252 tons of crude ore shipped to smelters containing 62,964.02 ounces of gold, 4,081,358 ounces of silver, 5,707,786 pounds of copper, 24,055,768 pounds of lead, and valued at $5,228,473, an average value of $31.45 per ton. Lead concentrates, largely carbonates, were produced at two mills. The total tonnage of the district was divided according to metallic content into 3,021 tons of dry or siliceous ore, carrying gold and silver; 111,194 tons of copper ore, generally with high values in gold and silver; 58,343 tons of lead ore, with gold and silver; and 24 tons of copper-lead ore. No zinc ore was reported. In 1908 the copper ores shipped represented about two-thirds of the ore produced in the district, and yielded about 85 per cent of the gold and 45 per cent of the silver; the lead ores, in tonnage and yield of gold and silver, largely made up the remainder. The principal ore bodies are found in the sedimentary rocks in four fracture zones, named from west to east according to the oldest or principal mine, the Eureka, Mammoth, Godiva, and Colorado zones, their general direction coursing north-south.

In 1908 there were 35 operators reporting production of ore from the first three zones (including those working in the igneous rocks). The output averaged per ton 0.414 ounce of gold, 18.51 ounces of silver, 2.01 per cent of copper, and 2.75 per cent of lead. Figures of an earlier output of the same region, about 1897,[a] give an average per ton in 240,000 tons (with copper and lead estimated) of 0.136 ounce of gold, 52.44 ounces of silver, 0.56 per cent of copper, and 13.5 per cent of lead. This average, compared with that of 1908, shows in the present period of production that the gold and copper have increased and the silver and lead have decreased. Differences in the averages may be largely accounted for by the greater tonnage of ore mined without sorting, as was the practice of many producers in earlier days. On the Colorado zone ore averages are higher and resemble the earlier output of the other three zones. In tonnage and yield of gold, silver, and copper, the Eureka zone exceeded all the others, but the Colorado zone, with about one-sixth of the tonnage, yielded the greatest quantity of lead and over four times as much silver per ton of ore.

Five mines of the Eureka zone shipped to smelters siliceous, copper, and lead ore in 1908, amounting in quantity to 119,809 tons and yielding an average of 0.441 ounce of gold, 17.35 ounces of silver, 2.39 per cent of copper, and 1.80 per cent of lead, with a total value of $26.13 per ton.

In the Gemini mine water was encountered at 1,700 feet and is being pumped out at the rate of 300 gallons per minute. These are the deepest workings in the district, the collar of the shaft being much lower than many of the others. The ore of the deeper levels is richer in copper than that found above. The Centennial Eureka mine yielded 112,855 tons of siliceous, copper, gold, and silver ore containing a small percentage of lead. The output of 1908 was an increase of 7,939 tons over that reported for 1907. When the company furnaces at Bingham Junction were closed in 1908, the ore was shipped to other smelters in Utah and California. Prospecting has been

[a] Tower and Smith, Geology and mining industry of the Tintic district, Utah: Nineteenth Ann. Rept., U. S. Geol. Survey, pt. 3, 1897–1908, p. 687.

fully kept up in the property, and new ore bodies have been opened. Those on the lowest levels are stated by the company to be as large and as rich as the ores heretofore mined.[a] The main shaft was sunk to the 2,000-foot level in 1908, which is 2,300 feet below the collar of the shaft. At the bottom of the shaft, which is in porphyry, water was encountered, but not in quantities to be troublesome. The 2,100-foot level of this property is about on a level with the 1,700-foot level of the Gemini mine. In 1908 control of the Bullion Beck and Champion mines was bought by the United States Mining Company, which is developing this property from the Centennial Eureka workings; but shipments of ore were continued by the lessees of the Bullion Beck. The Eureka Hill property continued to produce ore, partly by lessees and partly by company operations, from near the surface, and the ore was furnished the smelters for its silica. It is reported that the siliceous ore contains from $3 to $10 in gold and silver. Some silver bullion resulted from a clean up of the old Eureka mill, which is soon to be dismantled. The Opex property, located on the Eureka zone, was nearly 2,000 feet deep in limestone with a 3-compartment shaft. Drifts have been driven north and south from the shaft on the 1,300-foot level. In the workings of the Emerald property a porphyry dike, 4 feet wide and striking north-south, was encountered on the 1,100-foot level. A drift is being extended along this dike to the north. No ore has been shipped from either property. The operators of the King William claim began development in October through the workings of the Eagle and Blue Bell property, which adjoins on the north.

Seven mines of the Mammoth zone produced a total of 13,687 tons of siliceous, copper, and oxidized iron ore, containing an average of 0.343 ounce of gold, 23.25 ounces of silver, 1.71 per cent of copper, and 4 per cent of lead, and an average value of $27.28 per ton. The Mammoth mine is 2,360 feet deep, a 370-foot winze extending from the 2,260-foot level, making the deepest workings of the property 2,630 feet. Regular shipments of copper ore were made in 1908 to the Garfield smelter and of lead ore to Bingham Junction. The Lower Mammoth mine continued supplying ore in 1908 to the Tintic smelter until that establishment closed for repairs. At the Grand Central and Victoria properties development work has been actively kept up, but shipments of ore were curtailed on account of metal prices. Development work was performed mainly on the 1,800-foot and 2,000-foot levels of the Grand Central. Lessees operated the Eagle and Blue Bell mine, shipping a siliceous copper ore to the Garfield smelter. The Little Chief claim was developed by the American Mines Syndicate Company. The Black Jack Consolidated Company, which took in the Star Consolidated properties, has about completed its 2,100-foot tunnel, through which it will handle the ore, thus placing the ore upon the cars without a wagon haul. The Opohonga will probably have a production in 1909. It is possible to work this property through the Black Jack mine, which adjoins on the west.

The Godiva ore zone yielded mainly lead ore, consisting largely of sulphides, but some copper ore containing no lead was produced by 2 companies. The copper ore averaged in copper 12.05 per cent

[a] Third Annual Report of the United States Smelting and Refining Company, 1908.

and in silver 3.8 ounces per ton. The total quantity of ore amounted to 19,700 tons, produced from 8 properties and containing an average per ton of 0.101 ounce of gold, 18.23 ounces of silver, 0.81 per cent of copper, and 17.23 per cent of lead, and a total average value of $28.34 per ton. The Yankee Consolidated Company was developing on the 300-foot and 400-foot levels, drifting toward the Beck Tunnel vein and doing some prospecting on the 500-foot and 600-foot levels. A new company has been organized, known as the "Plutus Consolidated," which took in the Tetro property. Some ore was shipped from the latter in 1908. In 1903–4 the operators of the Plutus claims shipped 1,250 tons, which netted the owners $70,000 for the gold, silver, copper, and lead. Lessees worked in the Godiva mine during four months of 1908 and shipped ore. The shaft, which is 975 feet deep, is being deepened. The operators of the May Day mine commenced shipments of lead ore in April, continuing the remainder of the year. In the Uncle Sam mine there was opened up a very rich ore body, which consisted largely of galena. At the Victor and the Carisa properties development work on the 800-foot level promised to have an important bearing on the future of the mines. Lessees in 1908 shipped copper ore from these mines.

Four mines on the Colorado zone were productive in 1908, as compared with 2 in 1907. Shipments consisted largely of lead carbonate and some iron ore and aggregated 18,226 tons, which contained an average of 0.198 ounce of gold, 72.89 ounces of silver, 0.1 per cent of copper, 34.89 per cent of lead, and an average value of $72.29 per ton. This average is lower than it would have been but for the included production of oxidized iron ore. The Colorado property, which first produced in 1907, continued to furnish a high-grade silver-bearing lead carbonate. Part of the ore was treated at a Salt Lake Valley smelter until the Tintic Smelting Company began to operate. The territory owned by the Colorado Company is extensive and the ore body large. The deepest workings are not over 370 feet. Important developments on the Iron Blossom property occurred the latter part of 1908 in opening up some low-grade iron ore on the 400-foot and 500-foot levels. On the 800-foot level the vein rock is reported to show indications of copper. In the Sioux property carbonate lead ore, similar to that found in the Colorado, its neighbor, was opened up, and some carloads were shipped to Salt Lake. Its deepest workings are 400 feet in depth. The Beck Tunnel mine continued its output of lead ore. Its deepest level is now 1,000 feet from the surface.

The igneous rocks in this district have always been productive of ores, nearly all of which contain lead and some copper, with gold and silver. The deepest mine workings are in the rhyolite at 800 feet. Some of the ore is sorted to bring it up to a shipping grade. There were 1,141 tons of ore, mostly sulphide, shipped to smelters in 1908. The average of the ore shipped did not represent the grade mined, as some oxidized iron ore from the contact deposits, also low-grade siliceous ores, are included in the average, which follows: Gold, 0.011 ounce; silver, 16.37 ounces; copper, 1.27 per cent; lead, 4.23 per cent; an average value of $15.81 per ton. The water in the Swansea mine, located in the rhyolite, has been lowered below the 800-foot level. On its 700-foot level north and south of the shaft some ore was taken out and shipped to the Tintic smelter. The water pumped from the

mine furnished the smelter with its supply. The North Clift mine, which has a shaft 400 feet in depth, produced from the 125-foot level. The Bullock property has a shaft 150 feet deep. From each property lead ore was shipped in 1908. Other properties producing in 1908 were the United Sunbeam, Laclede, Homestake, Showers, Shoebridge, Silver Park, Undine, Windridge, and Brooklyn.

MORGAN COUNTY.

Argenta district.—In this district the Carbonate Hill and Lucky Boy properties were developed in 1908. About 50 tons of lead ore were shipped from the former property.

Morgan district.—The Chicago-Utah and the Morgan Crescent properties were operated, and some copper ore was reported as shipped from one of the claims.

PIUTE COUNTY.

Gold Mountain district.—The Annie Laurie mine was operated part of the year, and some ore was treated in its cyanide mill. The property went into the possession of a receiver, and the mine and mill were closed in August. In the same district on the Sevier County side are the Sevier mine and mill, which were idle during 1908.

Ohio district.—Lead ore, amounting to 20 tons in quantity, was shipped from the district to the smelters near Salt Lake. The properties being developed during 1908 were the Cascade, the Eldorado (formerly the Standard), the Webster, and the Sixteen to One.

SALT LAKE COUNTY.

Big and Little Cottonwood districts.—The combined output of these districts produced from 21 properties in 1908 was shipped in the form of crude ore and concentrate to smelters near Salt Lake. The total production, valued at $101,061, aggregated 5,866 tons. Of this output about three-tenths was concentrated and yielded 1,090 tons of concentrate containing 36.40 ounces of gold, 22,838 ounces of silver, 88,064 pounds of copper, and 223,921 pounds of lead, a total value of $33,885, and an average of $31.09 per ton. The remainder of the output of the two districts, including 1 ton of old slag, was crude ore shipped direct to smelters and aggregating 1,876 tons, which contained 284.96 ounces of gold, 40,408 ounces of silver, 181,248 pounds of copper, 379,919 pounds of lead, with a total value of $67,176, or an average per ton of $35.80. Copper-lead ores comprise four-tenths of the output and are produced in the Little Cottonwood district. The remainder is lead ore, some of it containing small quantities of copper. The ore occurrences are mainly replacement deposits in limestone. Operators of mining property adjacent to and in Big Cottonwood Canyon reported development work, during which some ore was shipped in 1908. At the Mountain Lake property the main adit has been extended 1,480 feet, during which development copper ore containing gold and silver was shipped to the Tintic smelter. Some lead-silver ore was found in the Cardiff adit, which is 900 feet long. No shipments were made. The Maxfield mine

was operated by lessees. Other producers were the Gypsy Blair, the Copper Apex, the Scottish Chief, and the Carbonate Mining Company.

Near Alta, on the Little Cottonwood side, the South Columbus Consolidated, originally a consolidation of the South Columbus and the Alta Quincy, absorbed in 1908 the Columbus Wedge. This group of properties have all been recent producers of copper-lead ore containing gold and silver. An ore body of some importance was opened up on the 600-foot level, where ore was reported to assay 6 per cent of lead, 25 ounces of silver, 10 per cent of copper, and iron in excess of the silica. Through the Alta Quincy tunnel, which is about 2,000 feet long, another ore body was found. A drift from the tunnel opened up sulphide ore for a distance of 100 feet, the vein averaging about 4 feet in width. An electric plant generated by water power was installed on the property in 1908. The Unity Mines Corporation, controlling the Continental Alta mine and aerial tramway line, did no development work in 1908, but some ore was shipped by lessees. The Wasatch Mining Company, operating the Consolidated Jefferson mine, did development work and at the same time shipped ore containing high values in gold. A vein which at the surface outcrops for a distance of 1,000 feet is the objective point of a drift from the bottom of the 200-foot shaft. From the Albion property 2 cars of lead-silver ore were shipped. The Alta Hecla Company secured the Lillburn group of claims in 1908. It extended the old Scott tunnel on this property and encountered the ore, which mainly contained chalcopyrite, assaying 0.16 ounce of gold, 14 ounces of silver, 4 per cent of lead, and 14 per cent of copper. One shipment of lead ore from the Flagstaff mine was taken out during development, which consisted of extending the Tom Moore tunnel 1,382 feet farther to a total of 4,882 feet. This adit is expected to provide entrance to the old workings. From the upper workings of the City Rocks property ore was mined and shipped, and also from some of the other claims, as assessment work became due. The main adit at the foot of Patsey Marley Hill was continued 100 feet farther toward the objective point. The Old Emma Mine Company, a new organization, cleared a portion of the old workings of this once famous property and several shipments of lead ore were made. Near the headwaters of the Little Cottonwood Creek and extending over into Big Cottonwood are the Black Bess claims, which were once producers and which have been largely developed during recent years. In 1908 the Utah Coalition Mines Company was organized to operate the property.

Mine production of gold, silver, and associated metals in West Mountain or Bingham district, Salt Lake County, Utah, in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	75,730.24	$1,565,483	60,382.69	$1,248,221	− 15,347.55	− $317,262
Silver.....do....	1,786,580	1,179,143	1,053,146	558,168	− 733,434	− 620,975
Copper.....pounds..	45,431,964	9,086,393	71,155,740	9,392,558	+25,723,776	+ 306,165
Lead.....do....	21,871,064	1,164,466	15,169,518	637,120	− 6,801,546	− 527,346
	.....	12,995,485	.....	11,836,067	.....	−1,159,418

Bingham district.—This district yielded the largest tonnage of ore produced in the State, the output in 1908 having been about seven-tenths of the state total, or 2,691,640 tons. Of this 2,412 tons were siliceous ore, 2,633,181 tons copper ore, 55,848 tons lead ore, and 189 tons copper-lead ore. No ore was mined for zinc, although this metal was found in some of the mines in high percentages. The principal ore bodies of this district occur in igneous rocks and in the adjacent sedimentaries, and they have been described in a report published by the Survey.[a] They include fissure veins, replacement deposits in limestone, and large irregular bodies in the monzonite porphyry. The ores mined from the latter class of deposits are essentially copper ores, while those in the former classes include both lead and copper ores. In 1908 there were shipped of monzonite porphyry ore to concentrating mills 2,120,192 tons, representing 98 per cent of the total ore mined at Bingham. The concentrates from the monzonite ore amounted to 77.7 per cent of the total production. The ore concentrated averaged per ton 0.007 ounce of gold, 0.69 ounce of silver, and 1.15 per cent of copper, and amounted to 99,164 tons of concentrates, containing per ton 0.16 ounce of gold, 1.47 ounces of silver, and 24.66 per cent of copper. The ratio of concentration, 21.4 into 1, was higher than in 1907, and the yield was therefore somewhat lower, as one of the companies mined a large quantity of surface overburden, which averaged low in metal content. The low-grade bodies of copper ores in monzonite are mined by the Utah Copper Company, the Boston Consolidated Company, and the Ohio Copper Company. Steam-shovel mining is commonly used at the first two properties, which in underground mining also adopt the caving system, this latter method being altogether in vogue in the other properties. The Ohio Copper Company confined its operations to development work. In 1908 the output of the Utah Copper Company was about two-thirds greater than in 1907. According to its annual statement, there were produced 43,873,918 pounds of copper, 140,263 ounces of silver, and 15,455.44 ounces of gold, aggregating in total value $6,185,188. This is equivalent to 88 per cent of the output made in eighteen months' operation of the concentration mills at Copperton and Garfield. During this time the concentrate, consisting principally of chalcocite and chalcopyrite, averaged in copper approximately 27 per cent. Copper sold during this period brought an average price of 13.2 cents per pound. The average cost of producing the copper was 8.85 cents per pound, this being based upon all expenses of transportation, refining, and disposition of the metal. The two mills of the company treated in 1908 an average of over 5,000 tons of monzonite porphyry daily, but under better transportation facilities the quantity treated will greatly exceed 6,800 tons, the average rated capacity of the plants. The grade of ore treated in 1908 was probably lower than it will be in the future, as much of the low-grade capping of oxidized material could not be kept from mixing with the ore. Experiments made on the oxidized ore demonstrate that the larger part of the copper can be extracted by a simple leaching process, for which the company proposes to erect a large plant. Underground mining is decreasing and steam-shovel work rapidly increasing. Average mining costs during

[a] Boutwell, J. M., Economic Geology of the Bingham mining district, Utah: Prof. Paper U. S. Geol. Survey No. 38, 1905, p. 123.

eighteen months, including all general and fixed charges, were 66½ cents per ton for all ore mined by steam shovels. During 1908 more than 10 miles of tunnels, drifts, and raises were driven, but at the same time there was a very large percentage of the underground workings destroyed, partly by stoping, but more largely as the result of the operations of steam shovels over areas that had been previously blocked out by tunneling and drifting. About 80,000,000 tons of ore are said to have been developed in the company's property. Eight-tenths of the tonnage is classed as averaging about 2 per cent of copper and the remainder approximately 1½ per cent of copper. All the development done so far has been on the eastern end of the property and on both sides of the canyon, but the larger part of it has been on the south side of the canyon and on the southeastern portion of the area. The ore-bearing area is still being proved in that direction. Stripping operations with steam shovels in 1908 were represented by the removal of 967,283 cubic yards of material. The total area over which these operations have been conducted is 19.7 acres. The average thickness of the oxidized capping was found to be approximately 70 feet. The total material removed is, therefore, equivalent to stripping approximately 15 acres, and at the present time the actual area completely stripped is slightly in excess of 7 acres.

The Ohio Copper Company, which partly equipped its property with a concentration mill during 1908, will likely be delayed in completing it until late in 1909. The main adit is driven past the Ohio shaft, making the raise to connect with the main shaft. This adit enters the ore body at a depth of 520 feet vertically below the deepest present development of the mine, or about 1,394 feet below the collar of the shaft on the dip of the vein. The character of the ore in places in the mine is such as to allow the adoption of the caving system of mining.

At the Boston Consolidated property development of the porphyry mine with the use of steam shovels was intermittent during certain periods and finally discontinued. A grade of ore entirely unlooked for, containing a large percentage of iron pyrite, which served to lower the concentration ratio of the ore by 50 per cent, was encountered in the porphyry mine, and underground mining by the caving system was resumed and relied upon to supply the increased capacity of the mill at Garfield. The fact that the company's contract with the smelter contained no provision to take care of the excess of iron was given as a reason for discontinuing steam-shovel work. During the fiscal year of the company it shipped to the Garfield smelter 79,300.65 wet tons of sulphide ore, containing 7,446.87 ounces of gold, 55,704.85 ounces of silver, and 3,459,911 pounds of copper. The mill, commencing operation of its first section on January 27, treated 143,284 dry tons of ore and produced 9,935 tons of concentrate, containing 397.41 ounces of gold, 4,967.64 ounces of silver, and 2,937,599 pounds of copper. This concentrate was placed in storage at the mill until the Garfield smelter was put in successful operation to receive it. Shipments commenced October 17. About 1,600 tons of ore are treated daily, and the extraction record at the milling plant is exceeding former published statements; a recent month's operation has reached 72 per cent, and daily averages above 80 per cent have not been uncommon.

Each of the smelters operating in Utah in 1908 was supplied directly from the mines of Bingham with crude ore aggregating 540,391 tons, and containing 43,067.76 ounces of gold, 808,613 ounces of silver, 22,026,831 pounds of copper, and 10,047,288 pounds of lead, valued at $4,648,382. Over nine-tenths of the smelting ore containing copper and lead was mined from replacement deposits in limestone and quartzite, the remainder coming from fissures in the various types of rocks. The replacement deposits yielded a low-grade copper sulphide, formerly the chief product of the district, which amounted in 1904–5 to a daily output of approximately 2,000 tons, produced by 5 great properties—the Highland Boy, the Boston Consolidated, the United States, the Bingham Consolidated, and the Yampa. Since then the Bingham New Haven has been added to these. All but the Bingham Consolidated Company were operating in 1908, each shipping ore to the smelters. Only the United States Company treated some of its low-grade ores at its concentrator and also shipped some siliceous ore containing only gold and silver to the smelter. The low-grade copper sulphide ores shipped from these properties in 1908 aggregated 502,857 tons, averaging 0.163 ounce of gold, 1.07 ounces of silver, and 2.08 per cent of copper. This ore was chiefly valued for its fluxing properties at copper smelters. The remainder of the ore went to lead smelters. It averaged 0.076 ounce of gold, 5.65 ounces of silver, 0.97 per cent of copper, and 10.54 per cent of lead.

The Utah Consolidated Mining Company shipped ore from the middle of February to the end of 1908 to the Garfield smelter. There were mined and shipped 248,215[a] tons of copper sulphide ore, yielding 10,788,473 pounds of copper bullion, which contained 10,648,243 pounds of copper, 265,283.79 fine ounces of silver, and 23,440.43 fine ounces of gold, aggregating in value $2,030,725 and averaging $8.18 per ton. No lead ore was shipped. The greater portion of the ore produced came from the stopes above No. 7 level. In the ninth level, which has been reached by the incline shaft, a large body of copper sulphide ore, assaying 3½ per cent of copper, is said to have been found. The sulphide ore in sight at the mine is, according to the annual statement, 1,487,218 tons. Electric haulage in the main working levels has entirely replaced that by horses and mules formerly used.

From the properties of the United States Mining Company 21,487 tons of ore containing gold, silver, copper, and lead were shipped to its smelters in 1908. Owing to the ore reserves heretofore developed the company has not found it necessary to push exploration work in the properties. It has, however, extended the lowest level of its mine for the purpose of completing the drainage, and this was effected by connection made with the 400-foot level of the Galena mine, and according to a statement made by the company it should be many years before it will be necessary to sink below the drainage level. This company has heretofore had no profit from the zinc contents of its ore. A plant is now being installed at Bingham Junction to render the zinc contents of the ore of commercial importance.

[a] Annual report Utah Consolidated Mining Company for the year ending December 31, 1908.

The Bingham New Haven Mining Company, operating through its new adit, which is driven for 2,500 feet, opened the mine at an additional vertical depth of about 450 feet from its upper adit. The face of the new adit is vertically about 1,500 feet from the summit of the mountain. Three ore bodies are said to have been opened, and a winze has been sunk in ore for 200 feet below its level. A concentration mill will be constructed in 1909.

The Tintic Mining and Development Company, operating the Yampa mine, made many new improvements during 1908; the mine has been deepened and its ore bodies have been placed in shape for economical mining. The company has an aerial tramway 3 miles long, capable of handling 800 tons of ore per day. The Yampa smelter has been enlarged and is capable of smelting 1,000 to 1,200 tons of ore daily.

The fissure veins yielded a lead-silver ore, aggregating 29,806 tons, three-fourths of which was shipped directly to smelters, the remainder going to concentrating mills. The combined tonnage as mined averaged 0.071 ounce of gold, 7.40 ounces of silver, 0.94 per cent of copper, and 12.57 per cent of lead. Companies mining ore from fissure veins in whole or in part are the Dalton and Lark, Sampson, Phoenix, Utah Apex, Silver Shield, North Utah, Fortuna, Mystic, Utah Bingham, Bingham Central, Utah Copper, and Ohio Copper.

The Bingham-Central-Standard Mining Company developed its property in 1908 through 3 adits, 2 of which are 2,000 feet long and the other 850 feet long. Some lead-copper ore was shipped by lessees. The Dalton and Lark and Commercial mines, which were formerly under control of the Bingham Consolidated, have been turned over to the Bingham Mines Company. Lessees shipped lead ore in 1908 from the Dalton and Lark mines.

The Utah Apex Company will henceforth develop its mines through the newly acquired property, including a new mill purchased of the Phoenix Company. Both companies were shippers of ore containing lead, silver, and some copper.

SAN JUAN COUNTY.

In 1908 the production of $4,330 in gold and 46 ounces of silver was from placers. Three-fourths of this yield came from San Juan River and the remainder from Grand and Colorado rivers. Some copper was reported from a small shipment of ore mined from the Lisbon Valley sandstone beds near the Colorado-Utah line, about 50 miles southeast of Moab, in Grand County. Only high-grade and closely sorted ores have been marketed from these deposits, the ore having to be packed on burros or hauled by wagon about 75 miles to Placerville, Colo. The copper ores, mostly carbonates, occur in subordinate quantities and will probably be economically treated by a leaching process employing sulphuric acid. On the Colorado side of the line it is understood that such a plant has been in operation and was enlarged during 1908 to treat the carbonate ores of the Pyramid property. With the utilization of water from Dolores River the power costs should be greatly reduced, offsetting the expensive wagon haul of sulphuric acid from a point 75 miles dis-

tant. The sandstone formations in which the copper ores occur are referred to in a Survey publication.[a]

Placer mining was productive from small operations on the high bars and ancient river channels up and down San Juan River from Bluff. The gold occurs in very fine flakes and is hard to save. Sluices with burlap tables seem to be the only practical means for saving the gold.

SEVIER COUNTY.

Near Salina, on Salina Creek, is the property of the Lead Hill Mining Company, equipped with a 5-stamp mill and concentrators. This plant was operated about twenty days in 1908 and yielded a shipment of lead concentrate containing a little copper and a trace of silver. The Sevier gold property is in the Gold Mountain district, which extends into Piute County, and is mentioned under that heading.

SUMMIT AND WASATCH COUNTIES.

The output of these counties is confined to the Park City region, which covers the mineral area. The production of metals in the region in 1907 and 1908 is shown in the following table:

Mine production of gold, silver, and associated metals in Park City mining region, Summit and Wasatch counties, Utah, 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	8,413.52	$173,923	5,083.34	105,082	− 3,330.18	− 68,841
Silver.....do....	2,794,552	1,844,404	2,463,735	1,305,779	− 330,817	− 538,625
Copper.....pounds..	945,722	189,144	541,061	71,420	− 404,661	− 117,724
Lead.....do....	36,234,757	1,920,442	34,051,699	1,430,171	−2,183,058	− 490,271
Zinc.....do....	258,784	15,268	1,405,652	66,066	+1,146,868	+ 50,798
	.....	4,143,181	.....	2,978,518	.....	−1,164,663

The Uinta and Snake Creek districts combined comprise an area known as the "Park City region," which extends into both Summit and Wasatch counties, and the mines at present productive in the region form a compact group. The ore-bearing fissures, coursing northeast and southwest and usually dipping to the north in the mines, are said to have been prospected by continuous workings extending over 5 miles through different properties. The ore occurs both in fissures and in limestone beds, usually making large ore bodies in the latter, replacing the limestone and occasionally the quartzite at the intersection of the beds and the fissures. In certain properties the bodies are said to form replacements in the limestone for over 100 feet and to follow the strike of the fissure. At times the ore bodies are found in the limestone a considerable distance from the quartzite, but all the ore bodies are connected with the fissures. In early years the fissures furnished the richest and largest part of the ore shipped. In 1908 nearly all the crude ore produced was of

[a] Emmons, S. F., Copper in Red Beds of Colorado Plateau: Bull. U. S. Geol. Survey No. 260, 1904, pp. 227–228.

lower grade and mined from the bedded deposits. Both the lodes or fissures and the replacement bodies occur in frequent and intimate association with porphyry. They are described in a preliminary paper[a] issued by the Survey. The workings in the district have reached a depth of 2,100 feet. Oxidized ores are still mined to a limited extent, but the bulk of the shipments of both crude ore and concentrate is composed of sulphides. These are essentially silver-lead ores with accessory gold and copper and a siliceous gangue. Zinc is a common associate in fissure ore, and it appears to increase in depth and toward the southwestern extension of the great fissure zone of this district, near the great intrusive mass of igneous rocks.

Eleven producers, 4 less than in 1907, reported in 1908 the production of 142,331 tons of ore, of which nearly one-fourth, or 34,095 tons, was mixed carbonate and sulphide lead ore shipped direct to smelters. The remainder of the ore, 105,260 tons and 2,976 tons of old tailings, were treated at concentration mills and yielded 28,214 tons of concentrates. According to the reported yield of the total concentrates produced, they averaged $1.36 in gold and 25.57 ounces of silver per ton, 0.3 per cent of copper, and 26.39 per cent of lead. Nearly all of the zinc middlings, mostly from the Daly Judge mill, were reconcentrated at the dry concentrator near Park City, of the Graselli Chemical Company, and the shipments of high-grade zinc concentrate were made to its eastern refinery. There were 4 wet concentration mills connected with the mines in operation in 1908, the Silver King, the Daly West, the Daly Judge, and the Adirondack; and besides these 2 small tailing plants worked over accumulated tailings along Silver Creek. The successful operation of the dry concentrator of the Graselli Company equipped with Sutton tables and the installation of Richards jigs and classifiers at the Adirondack mill were the most important features in connection with new equipment in milling plants.

The Silver King group of mines, according to the annual report of the Silver King Coalition Mines Company, has produced from the beginning of operations in 1892 to December, 1908, shipping ore and concentrate containing gold, silver, and lead having a total gross value of $26,801,414. The ore of shipping grade, 322,024 tons, had a total value of $20,585,948 and an average value of $63.92 per ton. With smelter and other deductions it yielded $48.29 per ton. In 1895 the milling and concentration of the lower-grade ores began. Up to the end of 1908 there were milled 455,506 tons of ore (figuring from a ratio of 3.8 into 1), which produced 119,870 tons of concentrate, having a gross value of $6,215,466, an average value of $51.85 per ton, of which the net value was $36.10 per ton. During the life of the property copper and zinc are not mentioned as having been marketed. The report deals largely with the future of the mines from the ores blocked out, stated to be 69,244 tons of shipping grade, averaging $73.11 per ton, and 29,795 tons of milling grade, averaging $17.39 per ton. The total gross value of the two classes of ore is reported to be $5,580,780.99. To make up these figures, average samples were taken of both classes of ore. The first-class ore assayed 0.133 ounce of gold, 50.3 ounces of silver, and 42.1 per cent of lead;

[a] Boutwell, J. M., Progress report on the Park City mining district, Utah: Bull. U. S. Geol. Survey No. 225, 1903, p. 148.

the milling ore averaged 0.039 ounce of gold, 41.1 ounces of silver, and 40.25 per cent lead. The sulphide concentrate carries 10 per cent of iron, 3 to 4 per cent of silica, and a low percentage of zinc not high enough for the smelters to penalize. Average mining costs for eight months to the end of 1908 were $5.64 per ton; the milling costs for the same period averaged $1.06 per ton of ore treated. There are two classes of ore brought to the mill, a sulphide and a carbonate. The 450-ton mill is equipped with crushers, rolls, Huntington mills, Hartz jigs, Wilfley tables, Frue vanners, and Wilfley slimers. Revolving screens do the classifying ahead of the jigs, and Callow traveling screens ahead of the tables.

The Daly West Mining Company in its annual statement reports having mined 25,146.6 tons of mill ore during 1908. This tonnage was treated in the Daly West mill and produced 4,424.3 tons of concentrates. The first class ore aggregated 12,760.4 tons. The concentrates and first class ore were shipped to the American Smelting and Refining Company. The mine was closed for the first five and one-half months, so that the output amounted to about half that of 1907. The largest tonnages of ore in 1908 came from the 900-foot and 1,550-foot levels. An attempt was made to sink the Daly West shaft to the 1,700-foot level, but it had to be abandoned on account of heavy water flow until the Ontario tunnel has drained the ground under the shaft. The milling plant operated for 150 shifts (of nine hours each) and treated during that time 24,511.5 dry tons of ore. The average assay of the crude ore and concentrates shipped in 1908 was as follows:

Average assay of crude ore and concentrates shipped by Daly West Mining Company, Utah, in 1908.

	Gold.	Silver.	Lead.	Copper.	Value.
	Ounces.	*Ounces.*	*Per cent.*	*Per cent.*	
Crude ore	0.0347	35.59	10.51	1.35	$17.69
Concentrates	0.0358	47.80	26.05	1.32	34.05

At the Daly Judge property development work and production were carried along without any serious delays during 1908. The ore mined aggregated 51,805 tons, of which all but 1,269 tons were milling ore and the rest was shipped direct to the smelter. Three products were made in the mill ore, as follows: Lead concentrate, 9,092 tons; iron middlings, 3,516 tons; and zinc middlings, 6,149 tons. The mill was in service 352 days of eight hours each, thus averaging 143 tons per day. The average metal content of these products per ton was as follows:

Average metallic content per ton of crude ore and concentrates of Daly Judge Mining Company, Utah, in 1908.

	Tonnage.	Gold.	Silver.	Lead.	Copper.	Zinc.	Iron.	Value.
	Shorttons.	*Ounces.*	*Ounces.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Crude ore	1,269	0.058	21.91	24.80	0.70	11.46	10.33	$24.42
Concentrates	9,091	.062	16.03	32.33	.18	8.70	20.19	23.57
Zinc middlings	3,049	.021	4.01	3.65	.....	27.33	16.43	4.87
Iron middlings	3,516	.04	7.23	11.51	.18	10.92	28.69	8.13

Ore was extracted from the 1,200-foot, 1,260-foot, and 1,400-foot levels, the first yielding over half of the tonnage.

The Adirondack Mining Company was organized in 1908 to operate the Glencoe group or Curtis property, located in the Blue Ledge district, in Wasatch County. A 150-ton mill was constructed the latter part of the year equipped with Richards jig and classifier. Both mine and mill are to be furnished with light and power by a hydroelectric plant installed by the company. A small output of concentrate containing gold, silver, and lead resulted from a test run of the plant in 1908.

Other producers in 1908 were the Wabash and American Flag properties.

TOOELE COUNTY.

In 1908 the county had 23 producers of gold, silver, copper, and lead, against 17 reporting in 1907. The tonnage of ore mined, 382,014 tons, was 71,213 tons greater than in 1907, but the total average value per ton of all the metals decreased from $6.40 in 1907 to $4.09 in 1908. The gold and silver average per ton, however, decreased only from $2.83 in 1907 to $2.79 in 1908. The gold yield was 41,969.96 ounces, valued at $867,596, in 1908, as against 27,612.02 ounces, valued at $570,791, in 1907, and nearly equaled the production made in 1906, valued at $922,658. The Consolidated Mercur gold mines in 1908 produced 95 per cent of the total value in gold. The production of silver was 378,373 ounces in 1908, as against 468,472 ounces in 1907. The copper production increased from 739,521 pounds in 1907 to 1,067,292 pounds in 1908. The lead output decreased from 13,518,601 pounds in 1907 to 8,438,295 pounds in 1908. Zinc ore was not shipped from any of the mines producing it in 1907. The only mills treating gold ore in the county were the Consolidated Mercur, at Mercur, and the tailing plant at Manning, both using the cyanide process. Only 2 concentration mills and several jigging plants were operated. The treatment by cyanide of 325,114 tons of gold ore, including an important tonnage of old tailings, yielded 41,694.03 ounces of gold and 76 ounces of silver, averaging in value $2.65 per ton. The concentration mills and jigging plants produced 18,263 tons of concentrates, yielding gold, silver, copper, and lead, valued at $372,258, and averaging $20.38 per ton. Crude shipping ore produced aggregated 12,197 tons, yielding 172.98 ounces of gold, 153,748 ounces of silver, 115,241 pounds of copper, and 5,412,236 pounds of lead, with a total value of $327,587, and an average value of $26.86 per ton. The new smelter of the International Smelting and Refining Company is to be constructed in Pine Canyon, near Tooele City. The building of a branch line from the smelter site, nearly 7 miles long and connecting with the San Pedro Railroad, was commenced.

Camp Floyd district.—There are in this district three distinct ore-bearing beds lying about the middle of a great series of Carboniferous limestone strata. The lowest of these beds consists of quartzite and dark, silicified limestone, carrying silver and small values in gold, called the "lower vein." The upper beds, lying from 100 to 150 feet above the "lower vein" and parallel with it, carry gold, but little or no silver, and are called the "gold ledges." The lower gold ledge is usually about 60 feet vertically above the "lower vein," and is called

the "middle vein;" the upper ledge is usually about 60 feet above the "middle vein," and is called the "upper vein." The ore bodies underlie thin sheets of altered porphyry intruded between the strata. As a general rule these porphyry sheets follow the lines of stratification of the country rock, but occasionally they cut across from one stratum to another. The ore bodies consist principally of altered limestone, though in places the overlying porphyry carries pay values. Ores mined from the gold ledges are divided into three classes, oxidized, mixed, and sulphide. The oxidized ore is generally of a reddish or brownish yellow color, is readily leached, and carries little or no sulphur or arsenic. The mixed ore is generally talcose and carries small quantities of sulphur and arsenic. The sulphide or base ore is generally very dark in color, sometimes of a greenish tint and sometimes almost jet black, and carries larger amounts of sulphur and arsenic.

The geology and history of the district are given in a paper[a] published by the Geological Survey.

Production of gold began in 1890, when the first successful mill to use the cyanide method was erected at Manning by the Mercur Gold Mining and Milling Company. Since that time until the end of 1908 the mines in the district have produced 3,961,421 tons of gold ore, which, treated by the cyanide process, yielded $14,177,893 in gold, an average of $3.58 per ton. Ninety-three per cent of the total value was the yield from ores mined in the Mercur and Golden Gate properties. The other properties contributing to the total output were the Sacramento, Geyser-Marion, Overland, and Sunshine. All of these properties have mills, but only the Mercur has been in active operation since it was built. Recently, for the fifth time, the Sunshine mill has been fitted up with an improved cyanide equipment. Previous failures have been caused by the talcose nature of the ore, which contains an average of about $3.50 in gold and from which the best saving by ordinary methods was less than half the value. The ore will be prepared for treatment by 2 gyratory crushers, revolving screens, and rolls; then elevated to the crushed-ore bin, from which, discharged on an endless-belt conveyer, it will go to mixer-classifiers of local type, thence to a Dorr classifier. The Moore filter process, with which the mill was already equipped, is to be used again. Both the mine and mill are owned by the Boston-Sunshine Gold Mining Company. At the Consolidated Mercur mill the quantity of ore treated per month is about 23,000 tons, from which $2.70 per ton in gold is extracted. The amount lost in tailings, 88 cents, shows that the ore treated contains $3.58 per ton.

Clifton district.—The Western Utah Copper Company, operating at Clifton, in the Deep Creek region, is reported to have 100,000 tons of ore blocked out that will assay 4.9 per cent copper and 3.8 ounces of silver and $1 in gold per ton. It contains 28 per cent of iron and 23 per cent of silica. The vein is said to be a contact between limestone and porphyry. It is opened by adits, which give a depth of 150 feet between the highest workings and the lowest adit. A winze has been sunk 275 feet below the bottom level.

[a] Spurr, J. E., Economic geology of Mercur mining district: Sixteenth Ann. Rept., U. S. Geol. Survey, 1894–95, pt. 2, pp. 366–454; also, Consolidated Mercur Mines Company Annual Report 1901, from which notes are taken.

Columbia district.—The Sharp mine, an early producer of lead-silver ore, was equipped the latter part of 1908 with a 50-ton concentrating mill equipped with rolls, Huntington screen jigs, and Wilfley tables. The mine is opened by 1,250 feet of tunnels. Lead carbonate and sulphide are found.

Ophir district.—The Ophir Hill Company produced regularly from its mine and mill, and the Cliff mine has opened new resources from which it recorded a banner year in its output of lead and silver. The Lion Hill Consolidated Company, formerly the Chloride Point, made several shipments of rich silver ore and its development promises a continuation of this record in 1909.

Rush Valley district.—The Honorine Extension Company is reported to have discovered on its 600-foot adit level a body of ore carrying lead and silver, and will likely ship during 1909. Lessees worked in the Honorine mine in 1908, shipping lead-silver ore. The mill was idle. The Stockton mine and mill recently described[a] were idle during 1908. The geologic formation of the district is of Carboniferous quartzite and limestone, these strata having a northerly strike and dipping 50° to 55° W. At right angles to the strike of the sediments are a series of parallel fissure-fillings 3 to 20 feet wide and dipping 70° N. The ore shoots encountered in these fissures sometimes entirely fill the width of the vein and are 50 to 100 feet long. They occur between calcite bands, which sometimes follow one or both walls and pitch 50° to 55° W. like the sediments. Igneous rocks are closely associated with the ores.

Silver Islet district.—This district is located about 10 miles east of the Nevada state line and about 9 miles north of Wendover, a station on the Western Pacific Railroad. Ore produced from this district was formerly hauled a distance of 35 miles north to Lucin, on the Southern Pacific Railroad. The Carrie Mack, Old Glory, Dominion, and Western Pacific mining companies have been developing. Shipments of ore, containing lead, copper, and silver, were made in 1908 from the Carrie Mack claims.

UINTA COUNTY.

No production was reported from Uinta County in 1908, but the construction of a 1,500-yard dredge on Green River marked an important event. The machinery for the dredge was hauled 70 miles from the railroad and the erection near the mouth of Cub Creek was completed in October. The placer ground is owned by the Uinta Placer Mining and Exploration Company, which is said to have expended $50,000 in the construction of the dredging plant. Operations were begun, but no definite information was given out concerning the success attending the first work other than that the winter weather caused the closing down of the plant before a clean-up could be made.

UTAH COUNTY.

Only 2 districts, American Fork and Tintic, were productive in Utah County in 1908. The latter district is mentioned under Juab County, and its production is included in the figures given. In 1908

[a] Eng. and Min. Jour., March 21, 1908, pp. 611–612.

there were 11 mining properties producing ore, 1 more than in 1907. These mines yielded 33,337 tons of ore, averaging in value $51.75 per ton for the gold, silver, copper, and lead. Compared with the figures for 1907 the tonnage decreased 8,210 tons and the average value per ton $4.58. The values of gold and silver contents per ton, however, decreased only from $28.28 in 1907 to $28.12 in 1908. The total output of metal aggregated 5,344.91 ounces of gold, 1,561,983 ounces of silver, 29,499 pounds of copper, and 18,643,220 pounds of lead, with a total value of $1,725,249. Compared with the production of 1907, decreases were made in the output of all the metals except silver. Of the production of 33,337 tons of ore 27,077 tons were shipped direct to smelters, the remainder being concentrated at mills. The ore of shipping grade was valued at $1,659,688, an average value of $61.29 per ton.

American Fork district.—Four properties produced 2,356 tons of ore, averaging $6.53 in gold and 27.52 ounces of silver per ton, and 0.55 per cent of copper and 29.43 per cent of lead, with an average value of $47.31 per ton.

The active working mines were the Miller, Dutchman, Sunday, and Surprise. Development work was carried on during 1908 in the Pacific, Texan, Whirlwind, Mountain Dell, Mineral Flat, Pittsburg, Merril group, and Burgess properties.

WASHINGTON COUNTY.

In the Harrisburg district the Silver Reef sandstone deposits produced a little silver. The silver occurs as a chloride in the ore, which is treated in a 5-stamp amalgamation mill.

About 35 miles northwest of St. George a new gold district, known as "Bull Valley," claimed attention.

WASHINGTON.

By Charles G. Yale.

PRODUCTION.

The total value of the production of gold, silver, copper, and lead in the State of Washington in the calendar year 1908 was $378,816, which is $19,819 less than that of 1907. In 1908 the gold yield was 11,718.07 fine ounces, valued at $242,234; the silver yield was 88,823 fine ounces, valued at $47,076; and there were produced 312,030 pounds of copper, valued at $41,188, and 1,150,429 pounds of lead, valued at $48,318. This all came from 64 mines, of which 27 were placers of different kinds, and 37 were deep mines, of which 16 were gold, 12 silver, 5 copper, and 4 lead.

The total tonnage of the State for the year was 37,633 short tons, as against 44,413 in 1907, a reduction of 6,780 tons. Stevens County had the largest tonnage and was also the largest producer of gold, silver, copper, and lead. Siliceous ore increased 1,969 tons, the output being 29,596 tons in 1908 as against 27,627 tons in 1907. Copper ores decreased from 14,691 tons in 1907 to 6,478 tons in 1908. Of lead ores there were 1,559 tons produced in 1908 as compared with 2,095 tons in 1907. The average recovered value in gold and

silver per ton in 1908 from the siliceous ores was $8.57 as against $9.13 per ton in 1907. The average value per ton in gold and silver of the copper ore was $1.85 and of lead ore $3.24. The average value per ton of all metals in the siliceous ores was $8.90; of copper ores, $6.68; and of lead ores, $34.19, or a general average value of $9.54 per ton.

The total quantity of siliceous ores treated in the State in 1908 at mills and smelters was 29,596 tons, yielding in gold and silver $253,591 and in value of all metals $263,498. The copper ores amounted to 6,478 tons, yielding $11,963 in gold and silver, and $43,298 in total value of all metals. The lead ores were 1,559 tons, yielding in gold and silver $5,045, or in all metals $53,309. The total value in gold and silver of all the ores was $269,624, and the total value of all metals was $359,130.

The statement of production for 1907 and 1908, showing increase and decrease, valued at each year's commercial prices, is as follows:

Mine production of gold, silver, and associated metals in Washington in 1907 and 1908.

	Gold.		Silver.		Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Pounds.*		*Pounds.*		
1907	12,532.70	$259,074	55,359	$36,537	297,812	$59,562	820,035	$43,462	$398,635
1908	11,718.07	242,234	88,823	47,076	312,030	41,188	1,150,429	48,318	378,816
Increase(+), decrease(−)	−814.63	−16,840	+33,464	+10,539	+14,218	−18,374	+330,394	+4,856	−19,819

GOLD.

The total gold production of Washington in 1908 was 11,718.07 fine ounces, valued at $242,234, as compared with 12,532.70 ounces, valued at $259,074, in 1907, a decrease in quantity of 814.63 fine ounces and in value of $16,840. The most productive of the counties was Stevens, with a yield of $183,893, followed in order by Ferry County, with $17,333, King, with $12,645, and Okanogan, with $7,998. The placers of the State yielded 942.24 fine ounces, valued at $19,478. From siliceous ores were obtained 10,737.33 fine ounces, valued at $221,960; from copper ores 36.13 fine ounces, valued at $747; and from lead ores 2.37 ounces, valued at $49. This makes a total from deep mines of 10,775.82 fine ounces, valued at $222,756; and a grand total from placer and deep mines of 11,718.07 ounces, valued at $242,234. The decrease in entire production is 814.63 ounces, valued at $16,840. The gold production from placers and different kinds of ores, by counties, with the increase or decrease, is shown in the following table:

Source of gold production in Washington, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Deep mines.				Grand total
		Dry or siliceous ores.	Copper. ores.	Lead. ores.	Total.	
Benton	1.02					1.00
Chelan	72.51	103.09			103.09	175.61
Clallam	174.83					174.83
Ferry	3.68	834.81			834.81	838.49
King		611.70			611.70	611.70
Kittitas	288.84					388.84
Okanogan	71.26	281.16	34.49		315.65	386.91
Snohomish	36.57		.92		.92	37.49
Stevens		8,892.73	.72	2.73	8,895.82	8,895.82
Whatcom	278.59	13.84			13.83	292.43
Whitman	14.95					14.95
Total	942.24	10,737.33	36.13	2.37	10,775.82	11,718.07
Increase (+) or decrease (−)	−115.23	−31.87	−669.90	+2.37	−699.41	−814.63

SILVER.

The silver production of Washington in 1908 was 88,823 fine ounces, valued at $47,076, as compared with 55,359 ounces, valued at $36,537 in 1907, an increase in quantity of 33,464 ounces and in value of $10,539. From siliceous ores was derived 59,794 ounces, an increase of 14,822 ounces over the production for 1907; from copper ores, 19,211 ounces, an increase of 16,241 ounces; and from lead ores, 9,426 ounces, an increase of 2,221 ounces. The increase from deep mines was 33,284 ounces. The placers yielded in 1908 only 392 ounces. Altogether the total increase of silver output in 1908 over that of 1907 was 33,464 ounces. The largest output of silver was obtained from Stevens County, which produced 53,296 fine ounces; the next county in importance was Okanogan, with 25,526 fine ounces; and Ferry County produced 7,906 ounces. Of the silver output, 19,211 ounces came from copper ores in Stevens, Snohomish, and Okanogan counties, and 9,426 ounces from lead ores in Stevens County. The following table shows the source of silver production by counties and by classes of ore, in 1908, with increase in each case:

Source of silver production in Washington, by kinds of ore, in 1908, by counties, in fine ounces.

County.	Placers.	Deep mines.				Grand total.
		Dry or siliceous ores.	Copper. ores.	Lead. ores.	Total.	
Chelan	32	64			64	96
Clallam	28					28
Ferry		7,906			7,906	7,906
King		1,732			1,732	1,732
Kittitas	109					109
Okanogan	142	23,218	2,166		25,384	25,526
Snohomish	8		45		45	53
Stevens		26,870	17,000	9,426	53,296	53,296
Whatcom	67	4			4	71
Whitman	6					6
Total	392	59,794	19,211	9,426	88,431	88,823
Increase (+) or decrease (−)	+180	+14,822	+16,241	+2,221	+33,284	+33,464

COPPER AND LEAD.

The 297,812 pounds of copper produced in Washington in 1907 brought a value of $59,562, but the 312,030 pounds mined and treated in 1908 were sold for only $41,188. The largest producer of copper was Stevens County, with 248,432 pounds; the next in importance was Okanogan County, which yielded 57,000 pounds; and Ferry, King, and Snohomish counties followed with smaller outputs. The low price of the metal during the year restricted production and retarded development of copper properties.

The lead output for the year was 1,150,000 pounds, valued at $48,318, which is 330,394 pounds more than was produced in 1907. Most of the output was derived from mines in Stevens County, though a small quantity came from King County.

MINING INDUSTRY IN WASHINGTON IN 1908.

The total value of the metals mined in Washington in 1908 was $378,816, which was $19,819 less than that of 1907. Both silver and lead increased in value of production; the losses were in the value of the gold and copper output. The tonnage of ore was 37,633 short tons, which is 6,780 tons less than were produced in 1907. This fact, taken in connection with the reduction in value of copper, shows why the total value of the yield of the State fell off in 1908. The counties which increased their gold output were Ferry, King, and Stevens, the latter showing the largest amount. Those counties showing decrease were Chelan, Kittitas, Okanogan, Snohomish, and Whatcom. The decrease of output was large in both Snohomish and Whatcom counties and accounts for the total falling off for the year. The increase in quantity of copper was due to operations in Stevens County, the other counties showing a falling off in this respect. The increase in lead also came from Stevens County.

The following table shows the production of gold, silver, copper, and lead in Washington in 1908, by counties:

Mine production of gold, silver, copper, and lead in Washington in 1908, by counties.

County.	Producing mines.	Tonnage.	Gold.		Silver.		Copper.		Lead.		Total value.
			Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
		Short tons.	*Fine ozs.*		*Fine ozs.*		*Pounds.*		*Pounds.*		
Benton	1	.....	1.02	$21	.....	.....	.....	.....	.....	.....	$21
Chelan	7	150	175.59	3,630	96	$51	.....	.....	.....	.....	3,681
Clallam	3	.....	174.83	3,614	28	15	.....	.....	.....	.....	3,629
Ferry	7	722	838.49	17,333	7,906	4,190	1,144	$151	.....	.....	21,674
King	4	560	611.70	12,645	1,732	918	1,689	223	3,500	$147	13,933
Kittitas	7	.....	288.84	5,971	109	58	.....	.....	.....	.....	6,029
Okanogan	9	1,504	386.91	7,998	25,526	13,528	57,000	7,524	.....	.....	29,050
Snohomish	4	2,783	37.49	775	53	28	3,765	497	.....	.....	1,300
Stevens	15	31,863	8,895.82	183,893	53,296	28,247	248,432	32,793	1,146,929	48,171	293,104
Whatcom	5	51	292.43	6,045	71	38	.....	.....	.....	.....	6,083
Whitman	2	.....	14.95	309	6	3	.....	.....	.....	.....	312
	64	37,633	11,718.07	242,234	88,823	47,076	312,030	41,188	1,150,429	48,318	378,816

The total tonnage, by kinds of ore treated, in each county of Washington in 1908 is given in the following table, together with the increase or decrease as compared with that of 1907 and the average values of ores:

Tonnage of ore sold or treated in Washington, in 1908, by kinds of ores and by counties, in short tons.

County.	Dry or siliceous ores.	Copper ores.	Lead ores.	Total.	Increase (+) or decrease (−) as compared with 1907.
Chelan	150	.....	.....	150	− 17
Ferry	722	.....	.....	722	− 1,446
King	560	.....	.....	560	+ 18
Kittitas	.....	.....	.....	.....	− 263
Okanogan	1,029	475	.....	1,504	− 523
Snohomish	.....	2,783	.....	2,783	−10,721
Stevens	27,084	3,220	1,559	31,863	+ 8,741
Whatcom	51	.....	.....	51	− 2,569
Total	29,596	6,478	1,559	37,633	− 6,780
Increase (+) decrease (−)	+1,969	−8,213	−536	−6,780	.....
Average recovered value per ton in gold and silver	$8.57	$1.85	$3.24	$7.16	+ $1.00
Average recovered value per ton of all metals	$8.90	$6.68	$34.19	$9.54	+ $1.06

The following table shows the number of mines in Washington, by counties, according to their chief product in 1908:

Number of mines, classified by chief product in Washington, in 1908, by counties.

County.	Mines reporting production.	Gold placer mines.				Deep mines.				
		Hydraulic.	Drift.	Sluice.	Total.	Gold.	Silver.	Copper.	Lead.	Total.
Benton	1	.....	.....	1	1	.....	.....	.....	.....	.....
Chelan	7	.....	.....	5	5	2	.....	.....	.....	2
Clallam	3	.....	.....	3	3	.....	.....	.....	.....	.....
Ferry	7	.....	.....	1	1	4	2	.....	.....	6
King	4	.....	.....	.....	.....	2	2	.....	.....	4
Kittitas	7	2	4	1	7	.....	.....	.....	.....	.....
Okanogan	9	.....	.....	2	2	4	2	1	.....	7
Snohomish	4	.....	.....	2	2	.....	.....	2	.....	2
Stevens	15	.....	.....	.....	.....	3	6	2	4	15
Whatcom	5	2	2	.....	4	1	.....	.....	.....	1
Whitman	2	.....	.....	2	2	.....	.....	.....	.....	.....
	64	4	6	17	27	16	12	5	4	37

REVIEW BY COUNTIES.

BENTON, CHELAN, AND CLALLAM COUNTIES.

In Benton, Chelan, and Clallam counties there were 11 mines producing in 1908. There are 5 surface placers and 2 deep gold mines in Chelan County, while in both Benton and Clallam the mines are all small placers. The Chelan County mines yielded $3,681 in 1908, an increase of a third more than in 1907. The deep producing mines were the Washington Meteor, at Blewett, and

the mines of the Wenatchee Gold Mining Company, at Wenatchee. The output was all from tailings. The producing placers were the Simbach, the Peake & Son, the Crawford, the Wilson, and the Cook. In the Chelan and Lakeside district the only prospect being developed is that of the Holden Gold Mining Company, which is using power drills. In Clallam County there was a production of $3,629 from 3 placer mines, the Loveless at Ozette, the Kaufman at Aberdeen, and the Sunset Mining Association at Moro, the last being the most important producer. There was no record of output from Clallam County in 1907.

FERRY COUNTY.

In Ferry County in 1908 operators of 6 deep mines and 1 placer reported output and there were 43 mines which showed no yield during the year. Almost the entire yield for the year came from deep mines, of which 4 were gold and 2 silver mines. The total output for the county was valued at $17,333 in gold, $4,190 in silver, and $151 in copper, a total of $21,674. In 1907 the county yield was $39,830, of which $26,346 was derived from copper alone. The falling off in copper output is therefore quite material. The gold increased from $4,032 in 1907 to $17,333 in 1908; but the silver decreased from $9,452 in 1907 to $4,190 in 1908. The main reason of the decrease in output for the year was the nonproductiveness of the mines of the British Columbia Mining Company, at Danville, which was the largest producer in the county, expecially in copper, in 1907. Operations in these mines in 1908 were confined to diamond drilling, about 4,300 feet having been drilled in 28 holes. As in 1907, the producing districts of the county were Danville, Meteor, and Republic. One small quartz mine was operated at Covada and 1 small placer at Palouse City. There was only 1 producer at Danville and 1 at Meteor.

Republic district produced gold and silver valued at $8,825 in 1907, and in 1908 the yield was valued at $19,533, a gain of $10,708. This total yield came from 584 tons of ore. Very little mining was done in the district during 1908, there having been but 3 producers—the Apollo Consolidated Gold Mining Company, the Insurgent Mining Company, and the New Republic Mining Company. The last was formerly called the Republic Mining Company, and the production for the year was made under lease and bond to the new company. Since the close of the year under the new management high-grade ore is being produced in quantity. Operators of 24 mines in the district reported no product in 1908, it being difficult to obtain money for development. The Black Tail mine has been sold to a Seattle company. The Surprise and San Poil mines were both under lease. The outlook in the Republic camp seems to be bright. The developments in the New Republic have given encouragement to the other mines in the district.

KING AND KITTITAS COUNTIES.

King County had 4 producers in 1908, all at Berlin—the Apex Gold mines, the mines of the Seattle Cascade Mining Company, the Gold Mountain Mining Company, and the Consolidated Gold Mines

Company. The combined tonnage was 560 tons, which was valued at $12,645 in gold, $918 in silver, $223 in copper, and $147 in lead, a total of $13,933, as compared with $10,698 in 1907. Operators of 24 mines reported no production in 1908. No returns of output were received from any of the mines at Baring, North Bend, or Skykomish.

The producing mines in Kittitas County in 1908 were all placers, of which 4 were worked by drifting and 2 by the hydraulic process. These mines are all at Liberty; they are the Emma and Fountain Head, the mines of the Golden Rule Mining Company, the Midnight Star, the Old Bigney, and the Sunflower and Weniger group. Their total output for the year was valued at $5,971 in gold and $58 in silver, a total of $6,029, which is $2,726 less than the yield of the county in 1907. There were no deep producing mines in the county in 1908, although 3 deep mines produced in 1907. At Liberty the Fanny Edel mine, owned by the Hellan Mining Syndicate, of Seattle, was steadily developed, as were several other claims of the company.

There is a 40-ton amalgamation and concentration plant on the Fanny Edel, but no ore was milled in 1908. No returns of production were received from the mines at Clealum, Ellensburg, Easton, Roslyn, or Martin.

OKANOGAN COUNTY.

In Okanogan County in 1908 there were 9 producing mines, of which 2 were placers, yielding $1,473 in gold and $75 in silver, or a total of $1,548. Seven deep mines produced 1,504 tons of ore, of which 1,029 tons were siliceous and 475 tons were copper ore. This was 523 tons less than the output in 1907. The yield of the ore mined in 1908 was valued at $6,525 in gold, $13,453 in silver, and $7,524 in copper, a total of $27,502—an increase of $10,487 over the value of the product in 1907. The main increase shown was in the silver, though there was some increase also in the copper; the gold showed a falling off. The producing deep-mine operators in 1908 were the B. and F. Mining Company, at Bodie; Butcher Boy Gold Mining Company, Grant Consolidated Copper Company, and Yakima Gold Mining Company, at Chesaw; Hidden Treasure Mining Company, at Methow; Apache Mining Company, at Nespelem, and Ruby Mining Company, at Nighthawk. The mines of the B. and F. Mining Company, at Bodie, were worked only a short time during the year, and the mill was operated for only a month. This company has a 10-stamp mill with cyanide plant. In the Chesaw district no new properties were opened during the year. The Butcher Boy Company has no plant of its own and ships its ores to the Granby Smelter. The property of the Grant Consolidated Copper Company was developed by about 1,200 feet of underground workings, and is a comparatively new mine, work having commenced only in March, 1907. The ore was hauled 13 miles to the railway and thence shipped to the smelter. The Hidden Treasure Company, at Methow, has a small mill with concentrators, which was operated less than a month during 1908. No stoping was done in the mine, the work being mainly development. At the Apache property, at Nespelem, very little was done on account of lack of transportation facilities, though what ore was mined was shipped to the smelter. The Ruby Mining Company, at Nighthawk, operated its mine the first six months of the year only

and shipped ore to the smelter. At Conconcully no mines are producing, though some are being developed and are awaiting transportation facilities. There were no producers at Loomis, though there are numerous mining properties at that place. At Mazama, Lucky Jim, the Flag, and the Daisy mines only development work was done in 1908. No reports of productive mines were received from Oroville, Silver, Twisp, Wauconda, Winthrop, or Wehesville in this county.

SNOHOMISH COUNTY.

Operators of only 4 mines reported production in Snohomish County in 1908, of which 2 at Sutton were placers, and 2 were deep, one being at Reiter and the other at Index. Only copper ores are mined. The value of the yield of the county was only $1,300 for the year. There was a falling off in tonnage, wholly in copper ores, of 10,721 tons, as compared with the output of 1907. The Bunker Hill Mining and Smelting Company, at Reiter, has a 50-ton reverberatory furnace and a 100-ton concentrator. The smelter was blown in during 1908 for a demonstration run, but operations were not continued. On this property are 2 shafts, 86 and 800 feet deep, and over 5,000 feet of tunnels, as well as 1,200 feet of diamond-drill holes. The Ethel Consolidated Mining Company, at Index, has a 50-ton concentrator, but the plant was only operated one month in 1908, most of the work being done toward development of the mine. The mine has 2 tunnels, 500 and 400 feet long, respectively. In the Darrington section no new claims were located in 1908, and only assessment and development work was done on a few mines. At Granite Falls the Wayside mine was operated about nine months of the year for development purposes. No production was made. The 100-ton reduction plant consists of crusher, roll, jig, and table concentration. There was no production from mines in the Monte Cristo, Silverton, or Sultan districts.

STEVENS COUNTY.

Stevens County continues to be the most important producing county in the State of Washington. In 1908 the total value of the yield of the county was $293,104, as compared with $217,348 in 1907, a gain of $75,756. This was even more of an increase than in 1907, and shows clearly the progress made. In detail, the output of the county for the year was valued at $183,893 in gold, 53,296 ounces of silver, 248,432 pounds of copper, and 1,146,929 pounds of lead, with a total value of $293,104. The increase in value of gold for 1908 over that of 1907 was $34,305; of silver, $16,961; of copper, $19,784; and of lead, $4,709. Fifteen deep mines produced in 1908. Of these 3 were gold, 6 silver, 2 copper, and 4 lead producers. There were received reports from 71 mines which made no production during the year. There were 31,863 tons of ore treated in 1908, of which 27,084 tons were siliceous ores, 3,220 were copper ores, and 1,559 were lead ores. This is an increase of 8,741 tons over the production of 1907. The producing mines were those of the Deer Trail Consolidated Mining Company and the Robena Silver Lead Company, at Bossburg; the United Copper Mining Company, at Chewelah; Norman King, at Colville; British Columbia Copper Company, at Marcus; First Thought Gold Mines (Limited), and Bucher, at Pierre Lake, whose

nearest post-office is Orient, Ferry County; Jupiter Lead Company, at Northport; Snyder & Baxter, at Springdale; Deer Trail Consolidated Mining Company, Deer Trail No. 2, Silver Seal, and Queen and Royal, at Turk; and Silverene and Banshee, at Valley. At Bossburg the Deer Trail Consolidated Mining Company is working the old Bonanza mine, and its lead product came from that property. The mine was worked only about five months in 1908. The Robena Silver Mining Company at the same place ships its lead-silver ores to the Tacoma smelter. Several new veins of ore have recently been opened on this property, some reported to show 3 feet of low-grade copper ore. The United Copper Mining Company, at Chewelah, has no plant and ships its crude ore, which carries copper and silver, to the Northport and Granby smelters. In 1908, 700 feet of tunnel and shaft work was done on this property. Several other companies were doing extensive development work. At Colville the only producer was the Norway King mine, from which was shipped lead-silver ore. The Frisco Standard Mining Company and the Meteor Mining Company have both been driving tunnels. At Turk, in Deer Trail district, the Deer Trail Consolidated Mining Company shipped silver ore carrying some gold. The operators of the Silver Seal and Queen mines shipped silver ore. Silver ore was also shipped from the Royal at the same place. The camp of Turk (or Deer Trail) has been very quiet, owing to the low price of silver and the distance from railroad transportation. At present it is impossible to ship profitably ore carrying 8 to 10 per cent of copper and 60 ounces of silver. From Hunters, Kettle Falls, and Loon Lake there were no shipments in 1908. From Marcus the British Columbia Copper Company shipped smelting ore to the Greenwood, British Columbia, and Grand Forks, British Columbia, smelters. The ore carries gold, silver, and copper. There are 8 claims in the group, the Napoleon being the only one worked in 1908, and this is opened by a main tunnel 500 feet long, an upper adit, and a "glory hole" or open pit. The mine was operated six months during the year. The First Thought Gold Mines (Limited), at Pierre Lake, is the most productive property in the State, and its output is mainly gold, with a small proportion of silver. From the Bucher mine, at the same place, small shipments were sent to the Northport smelter. At Metaline all the mine operators were awaiting the completion of the railroad, and only development work was done. The mines of the Spokane Lead Mines Company have a 50-ton concentrator, but only a little development work was done on them, and no ore was shipped. At Northport the Jupiter Lead Company continued shipping large quantities of lead ore. The operators of the Calumet and Hecla, at the same place, finished in December a new plant with 100-ton daily crushing and a 50-ton concentrating capacity. At Ryan assessment work only is being done on the mines. At Springdale, the operators of the Snyder & Baxter mine shipped silver-lead-copper ore to the smelter at Ponderay, Idaho. The mine is developed by a 1,400-foot tunnel and 3 crosscuts. At Valley, the Silvereen and Banshee mines were both small producers.

WHATCOM AND WHITMAN COUNTIES.

In Whatcom County there were only 5 producing mines in 1908, of which 4 were placers and 1 was a deep mine, all at Barron, in the Slate Creek district. The total output of the county for the year

was valued at $6,083, of which all but $38 was for gold. The county made a poor showing for the year, its total output being valued at $22,837 less than in 1907. Heretofore Whatcom has been the leading county in the State in the production of placer gold, but Kittitas exceeded it in 1908. The most productive placer was that of the Granite Creek Gold Mining Company, at Barron, worked both by hydraulic process and by drifting. The Minnesota quartz mine, operated by the Seattle-St. Louis Mining Company, during the year erected a 20-ton stamp mill with concentrators; the mill was not operated in 1908. At Bellingham and Sumas no mines produced during the year.

Whitman County reports only 2 producing mines, both small placers with a combined output valued at $312.

WYOMING.

By Charles W. Henderson.

PRODUCTION.

The mines of Wyoming during the calendar year 1908 produced 385.02 fine ounces of gold, valued at $7,959; 3,998 fine ounces of silver, valued at $2,119; and 2,452,049 pounds of copper, valued at $323,670, a total of $333,748 in value. This was a total decrease in value of $129,578 as compared with the production of 1907. In quantity, there was an increase of 283 fine ounces in silver and an increase of 194,399 pounds of copper, but the lower average value for these two metals for the year 1908 caused a loss in value of $333 in silver and of $127,860 in copper. The decrease in gold of 67 fine ounces was due to a smaller production from the placer mines. The deep-mines yield in 1908 was greater in quantity of all three metals—gold, silver, and copper—than in 1907. Only 6 deep mines produced in 1908 as compared with 11 in 1907. There were 5 small placers in 1908 as compared with 8 in 1907, and they yielded $820 in gold in 1908, a falling off of $3,225.

The tonnage sold or treated in 1908 was 19,031 short tons as compared with 26,137 tons in 1907, a decrease in 1908 of 7,106 tons. In 1908 siliceous ore mined amounted to only 5 tons, the remainder, 19,026 tons, being all copper ore. Deep mines yielded $7,139 in gold, 3,990 fine ounces of silver, and 2,452,049 pounds of copper, at an average value per ton of $0.375 in gold, 0.21 fine ounce in silver, and 6.44 per cent of copper.

The copper yield, valued at $323,670, represented 97 per cent of the value of the State total.

Mine production of gold, silver, and copper in Wyoming, in 1907 and 1908.

Metal.	1907.		1908.		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	452.02	$9,344	385.02	$7,959	− 67.00	− $1,385
Silver.....do....	3,715	2,452	3,998	2,119	+ 283	− 333
Copper.....pounds..	2,257,650	451,530	2,452,049	323,670	+194,399	−127,860
	.....	463,326	.....	333,748	.....	−129,578

The increase in the quantity of the yield from deep mines was due to a somewhat larger output from the mines and smelter at Encampment, Carbon County, and from several shipments of high-grade copper ore from Hartville, Laramie County, and from Copper Mountain, Fremont County. The last-named district expects soon to be reached by the railroads, and the camp will be in a position to ship ores when the heavy cost of the long wagon haul to the railroad has been eliminated. Lessened operations in the placer camps of the South Pass district, Fremont County, and the Jackson Hole district, Uinta County, caused the decrease in gold yield for the State.

Source of gold and silver production in Wyoming, in 1907 and 1908.

	Number of mines.	Tonnage.	Gold.		Silver.		Total value.
			Quantity.	Value.	Quantity.	Value.	
Deep mines:		*Short tons.*	*Fine oz.*		*Fine oz.*		
Siliceous ore	6	5	345.35	$7,139	3,990	$2,115	$9,254
Copper ore	.....	19,026	.....	.....	.....	.....	.....
Total, 1908, deep mines	6	19,031	345.35	7,139	3,990	2,115	9,254
1907 deep mines	11	26,137	256.34	5,299	3,641	2,403	7,702
Increase (+), or decrease (−)	−5	−7,106	+ 89.01	+1,840	+349	−288	+1,552
Placer mines, 1908	5	.....	39.67	820	8	4	824
Placer mines, 1907	8	.....	195.68	4,045	74	49	4,094
Placer decrease (−)	−3	.....	−156.01	−3,225	− 66	− 45	−3,270
Total, 1908, deep and placer mines	11	19,031	385.02	7,959	3,998	2,119	10,078

Mine production of gold, silver, and copper in Wyoming in 1908, by counties.

County.	Producing mines.	Tonnage.	Gold.		Silver.		Copper.		Total.
			Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
		Short tons.	*Fine ozs.*		*Fine ozs.*		*Pounds.*		
Albany, Carbon, and Laramie	3	18,927	318.99	$6,594	3,123	$1,655	2,417,366	$319,092	$327,341
Crook	3	.....	11.27	233	2	1	.....	.....	234
Fremont	3	104	26.36	545	867	460	34,683	4,578	5,583
Uinta and unapportioned	2	.....	28.40	587	6	3	.....	.....	590
	11	19,031	385.02	7,959	3,998	2,119	2,452,049	323,670	333,748

REVIEW BY COUNTIES.

ALBANY, CARBON, AND LARAMIE COUNTIES.

These three southern counties in Wyoming, with one productive mine in each county in 1908, produced 18,927 short tons of ore, from which was won $6,594 in gold, $1,655 in silver, and 2,417,366 pounds of copper, valued at $319,092, a total of $327,341, or 98 per cent of the total value of the State yield.

ALBANY COUNTY.

A small production was made by one producer in this county, at Centennial. Several tons of ore from the Fram mine were worked in a small arrastra.

There were 17 nonproducing mining companies in this county in 1908, which reported assessment or development work.

In the Jelm Mountain district, near Jelm and south of Laramie, are several mines. The American Gold and Copper Company operates the Jessie mine. On the property is a 10-stamp mill, with concentrators. The Annie Mining Company's plant is also a 10-stamp mill, with concentrators. The operators of the White Swan group are reported to have opened high-grade copper ore, carrying both gold and silver. The Wyoming Queen Mining Company reports a 10-stamp mill on the property; the mine is opened by a shaft 250 feet deep.

In the Douglas Creek district, near Holmes and Centennial, reports were received from the American Gold Placer Mining Company, the Gold Exploiting Placer Company, the North Fork Mining and Development Company, and the Rambler Copper and Platinum Company. The last-named company reported 4,000 feet of underground development, and that ore was shipped in January, 1909. The ore is valuable for platinum, iridium, and copper. The American Gold Placer Company's sluices were obstructed by ice late in 1908 before a clean-up was made.

The Utopia Gold Mining Company, near Centennial, and in the Medicine Bow district, reported 300 feet of an 800-foot adit driven in 1908.

No work was done in 1908 on the property of the Strong Copper Mining Company, in the Horse Creek district, near Leslie.

In the Laramie Peak district, near Esterbrook, are the mines of the Boston-Wyoming Copper Company, developed by a 335-foot vertical shaft.

CARBON COUNTY.

The only producer in this county was the Penn-Wyoming Company, at Encampment. According to the annual report published in the Engineering and Mining Journal, "the smelter of this company was operated only one hundred and nineteen days in 1908, producing 2,384,356 pounds of copper from ore yielding 125.6 pounds per ton."

No shipments were made by other companies in the district. The Independence Copper Company reported steady development work throughout the year. This property is 2 miles north of Dillon, and a 60-ton pyritic copper smelter was erected near the mine in 1908. The Congo Mining Company reported development and ore taken out. The Golden Edge Mining and Milling Company and the Rocky Mountain Copper Company reported development work.

The Snake River Consolidated Mining Company, operating the Three Forks group, near Slater, Colo., reported substantial development work.

The West Virginia-Wyoming Copper Company has a 200-foot shaft on its property. Ore has been placed on the dumps awaiting the erection of a concentration plant.

At Arlington the operator of the Black Cloud and Red Cloud mines reported development work.

The Elkhorn Mining and Milling Company reported a shaft 150 feet deep and 300 feet of drifts on its property at Saratoga, with tonnage of copper ore on the dump.

The Elk Mountain Mining and Milling Company, operating 18 miles south of Walcott, has a shaft 210 feet deep on its property. Considerable development work was done in 1908, including sinking, crosscutting, and much surface prospecting.

Development work was reported by the following companies: The Jack Pot, at Copperton; the Itmay and Standard Copper companies, at Battle; and the Wyoming Copper and Gold Mining Company, at Encampment.

The Shawnee-Wyoming Copper Mining Company, at French, has developed its property by 3 vertical shafts, the deepest of which has attained 210 feet.

LARAMIE COUNTY.

A small shipment of copper ore was made from Hartville, in the Platte Canyon district. The workings on the Charter Oak, Gold Flake, and Silver Bow claims, in this district, are extensive in the aggregate.

In the northern part of the county is the town and district of Rawhide Buttes. The Copper Belt Mines Company has been operating in this camp for two and one-half years, and has 520 feet in shafts, 770 feet in tunnels, and 2,500 feet in drifts. The Copper Bottom Mining and Milling Company, with a 60-foot shaft on its property, expected to ship in 1909.

In the southwestern part of the county, near Hecla, is the Silver Crown district, in which are the mines of the Eagle Mountain Mining Company and the Monte Cristo Company.

BIGHORN COUNTY.

There was no production in Bighorn County in 1908. Development work was performed by the mining companies in the Wood River district, near Kirwin. The Galena Ridge Mining Company has an adit 2,025 feet long, and exploratory work was done on the property of the Gold Cliff Mining Company. The mine of the Gold Reef Mining and Milling Company was operated continuously during 1908. The adit on this property is now 1,578 feet long. The Shoshone Mountain Mining Company was driving an adit to open the deposit. There is a 700-foot adit on the Cuba mine of the Washakie Mining, Milling, and Smelting Company. Development work was also performed by the Shoshone Development and Improvement Company and the Wyoming Mining and Milling Company.

CROOK COUNTY.

The yield from Crook County came from the placer mines in the Hurricane district, northeast of Hurricane. The yield from 3 placers in 1908 was only $232 in gold, as against $600 in 1907.

Development work was performed on the Treadwell and Carrie L. groups, and on the property of the Roenna Mining Company, in the Hurricane district.

FREMONT COUNTY.

Fremont County, in 1908, produced from 3 deep mines 104 short tons of copper ore, which carried values of $545 in gold and $460 in silver and 34,683 pounds of copper—a total value of $5,583. This ore came from the Willow Creek and Copper Mountain districts. There was no placer yield from the South Pass district.

The proposed new work of the Burlington Railroad through the Copper Mountain region will aid greatly in the development of this new copper camp. The Mack Copper Company and the Three M's Mining Company shipped small lots of copper ore. Several cars of copper ore were shipped by the Williams-Luman Mining Company. This company's workings consist of a vertical shaft 630 feet deep and 1,200 feet of tunnels.

Exploration work was done by the Lucky Nine Mining and Development Company, the Thermopolis Copper Mining Company, and the Rochester-Shoshone Mining Company. The Wind River Mining and Milling Company has a 350-foot adit, and in 1908 began another adit 280 feet below the first. The equipment at the mine includes a 3-stamp mill.

In the South Pass district, near Atlantic and South Pass City, the Federal Gold Mining Company, on the Carissa mine, has a 500-foot shaft, and did considerable development in 1908. There is being built an electric plant to generate power for the mines in this district, and some of the properties may start again in 1909. There is a 20-stamp mill on the property of the Helen Gold Mining Company.

JOHNSON COUNTY.

No production was reported from this county. The Kelly Creek Mining Company operates the La Porte mine in the Bull Camp district, at Buffalo; there is a 5-stamp mill on the property. The Top Hand Mining Company and the Bull Camp Mining Company reported development work.

UINTA COUNTY.

Only a nominal yield was made from this county in 1908, from placers in the Jackson Hole district. In 1907, placers and one deep mine in this district made a substantial output.

SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES IN 1908.

(MINE PRODUCTION.)

By B. S. Butler and C. E. Siebenthal.

INTRODUCTION.

The following is an account of the production of silver, copper, lead, and zinc in 1908 by the mines of the Central States, including Arkansas, Illinois, Iowa, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States, which extends from the Appalachian system to the Rocky Mountain front, excluding the Black Hills. Most of the mines are developed in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

The statistics of production given in the following pages are based on reports made directly to the United States Geological Survey by the mines, and represent the quantity of metals recovered or paid for in the ore that was treated or sold during the year. These figures are in close agreement with those reported by the smelters and refineries, which represent the actual quantity of finished metal produced within the year, though not wholly from ore mined the same year.

Statistics of actual mine production were first collected for Michigan for 1906. The mine census of all of the Central States was first undertaken for the year 1907. Its continuation for the year 1908 makes possible the direct comparison of the production for two successive years which has been made in the following pages.

The method of marketing and recording the mine output in the lead and zinc regions of the Central States differs from that employed in the Western States. In the latter the miner usually sells his ore according to the assay content of metal at a certain price per unit. In the lead and zinc regions of the Central States, however, where the material sold is principally concentrates,[a] payment is made according to a basis price for a certain quality of concentrates. The details of this method are given in the pages devoted to Missouri. The figures which are reported to the survey by producers are tonnage and assay content of concentrates sold and amount received in payment. The total metal produced is calculated from the first two of these items. The reasonable agreement of the mine production with the smelter production, as shown in the general report on zinc in Mineral Resources for 1908, indicates that the calculations have given results very nearly correct.

In the case of Michigan the mines report the quantity of concentrate produced and the actual recovery of copper from concentrate

[a] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore."

smelted. In any year the mines may produce more or less concentrate than is smelted during the same period. The copper content of concentrate produced during the year but not smelted has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

The cooperation of all who have furnished information for this report is gratefully acknowledged.

PRODUCTION.

SILVER.

The production of silver in the Central States in 1908 was 292,237 fine ounces, which, at the average price of 53 cents per fine ounce, had a value of $154,885, as compared with 328,411 fine ounces, valued at $216,751, in 1907. No silver ores are worked in the Central States, and the comparatively small quantity of silver that is produced is recovered incidentally to the production of other metals. The greater part of the output comes from the copper lodes of Michigan, but lead ores of southeast Missouri and the lead-zinc-fluorspar deposits of the Kentucky-Illinois field also carry silver, some of which is recovered from the lead concentrates.

COPPER.

Complete figures of the production of copper in the Central States in 1908 are not given, in order to avoid disclosing the output of individual producers. Michigan and Missouri are the only copper-producing States, the former contributing nearly the entire copper output of the Central States. The copper production of Michigan in 1908 was 223,286,700 pounds, which, at the average New York price of 13.2 cents per pound, was worth $29,473,844, as against a production of 217,767,232 pounds, valued at $43,553,446, in 1907.

LEAD.

The production of lead by the mines of the Central States in 1908 was 153,361 short tons, which, reckoned at the average New York price of the metal for the year, $84 per ton, or 4.2 cents per pound, amounted to $12,882,324, as compared with 146,379 short tons, worth $15,516,174, in 1907. Missouri, as usual, leads the other Central States in the production of lead, and duplicated the record made last year by again taking first place in the United States. The disseminated lead district of southeast Missouri exceeded the production of the Cœur d'Alene district of Idaho and became the largest single lead-producing district in the United States.

ZINC.

The production of zinc in the Central States in 1908, based on returns from the mines, with a deduction for smelting loss, was 146,975 short tons. The value of this output, computed at $94 per ton, or 4.7 cents per pound, the average New York price of the metal for the year, was $13,815,650. The production of zinc in the Central States in 1907 was 156,027 short tons, valued at $18,411,086. Missouri again leads the Central States, and the United States as well, in the production of zinc.

SUMMARY OF PRODUCTION BY STATES.

The total value of the production of silver, copper, lead, and zinc in the Central States in 1908 was $56,326,703,[a] as compared with $77,697,457[a] in 1907. The contributions of each State and each metal to this total are shown in the following table:

Production of silver, copper, lead, and zinc in the Central States in 1908, by States.

State.	Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Pounds.*		*Short tons.*		*Short tons.*		
Arkansas					15	$1,260	605	$56,870	$58,130
Illinois	2,051	$1,087			399	33,516	1,717	161,398	196,001
Iowa					51	4,284	395	37,130	41,414
Kansas					2,518	211,512	14,119	1,327,186	1,538,698
Kentucky									
Michigan	241,055	127,759	223,286,700	$29,473,844					29,601,603
Missouri	49,131	26,039			144,459	12,134,556	107,404	10,095,976	22,256,571
Oklahoma					1,781	149,604	4,529	425,726	575,330
Wisconsin					4,138	347,592	18,206	1,711,364	2,058,956
Total	292,237	154,885	223,286,700	[a]29,473,844	153,361	12,882,324	146,975	13,815,650	56,326,703
Total, 1907	328,411	216,751	217,767,232	[a]43,553,446	146,379	15,516,174	156,027	18,411,086	[a]77,697,457

[a] Not including value of copper production of Missouri.

ARKANSAS.

By C. E. Siebenthal.

PRODUCTION.

The production of lead and zinc in Arkansas in 1908 is shown in the following table:

Production of lead and zinc in Arkansas in 1908, in short tons.[a]

District.	Ore.						Metal content.			
	Lead concentrates.		Zinc concentrates.				Lead.		Zinc.	
	Galena.		Sphalerite.		Silicate and carbonate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
North Arkansas	18	$985	516	$18,270	939	$21,469	15	$1,260	605	$56,870
Same, 1907	15	800	538	15,233	663	16,210	12	1,272	474	55,932

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York.

NORTHERN ARKANSAS.

Lead and zinc deposits have been known in Arkansas for many years. Lead was noted by Schoolcraft in his travels in 1819, and has been mined in a desultory way since the settlement of the State. Present development dates from about 1899, when there was a great

[a] Not including value of copper production of Missouri.

rush to the northern Arkansas field. The mines are principally in Marion County and in the adjoining portions of Searcy, Newton, and Boone counties, though there are also numerous mines and prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east. Until recently the mines labored under the disadvantage of a long wagon haul to the railroad and of high freight rates. The completion of the White River branch of the St. Louis, Iron Mountain and Southern Railroad and of the St. Louis and North Arkansas Railroad, has brought most of the producing mines within 10 miles of railway transportation, and greatly improved the situation as regards transportation. Other handicaps are the lack of keen competition among ore buyers, and the added cost and the loss of time in obtaining supplies and repairs, though these conditions will doubtless improve with the development of the field. Land for mining purposes is ordinarily leased in 10-acre tracts at 10 per cent royalty. Wood is universally used for fuel at the mines. At the close of 1908 there were 22 steam concentrating plants in the district. These are of the Joplin type, and average about 100 tons in daily capacity. Mining methods are similar to those in vogue in the Joplin region, except that owing to the rugged character of the country many deposits have been found outcropping on the hillside, and have been followed in by day levels. Shallow deposits are won by open pits. Hand drills are generally used, though a few of the larger plants have installed air or steam drills. At present prospecting is done by means of the churn drill, and an encouraging feature of recent work has been the greater depth to which prospecting has been carried and the reported ore strikes at depths around 300 feet as described in the district notes.

The ores are galena, sphalerite, and smithsonite. The sphalerite is generally very high grade, the concentrates, when clean, ranging well above the price basis, 60 per cent metallic zinc content. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, a yellow variety of smithsonite, known locally as "turkey fat," showing as high as eight-tenths of 1 per cent of cadmium. The prevailing low price of zinc ore curtailed the production throughout the year, particularly in those mines which have passed the development stage. Operations were largely confined to prospecting and to opening up new deposits rather than to exploiting the known ore bodies.

The ore bodies occur in fissures or crevices, in fault breccias, and in solution breccias. The ore deposits are for the most part found in the Yellville limestone of Ordovician age, but some also are found in the Boone formation of lower Carboniferous age.

Grateful acknowledgment is made of assistance rendered by Prof. R. W. Willett in the collection of the statistics of lead and zinc production of northern Arkansas in 1908.

REVIEW BY DISTRICTS.

Dodd City district.—The Pilot Rock Lead and Zinc Company prosecuted development work upon a shallow blanket formation of zinc carbonate ore at a depth of 35 to 50 feet. By means of a crusher and hand-jig plant a fair output of high-grade lead and carbonate ores was made. The Iola Cooperative Zinc and Lead Company confined operations to development work and got out a small produc-

tion of blende concentrates. The Susquehanna, Beatty, Bear Hill, and Nakomis mines were not in operation. On the last tract a drill hole is reported to be in ore from 297 to 324 feet.

Several old workings in this district were reopened during the year, among others the old Rising Sun mine, recently acquired, together with 640 acres of land, by the Rising Sun Mining Company. This mine consists of a tunnel 200 feet in length; it produced a considerable amount of lead in by-gone days.

Harrison district.—The Missouri and Arkansas Mining Company, operating 3 miles east of Harrison, made a fair output of blende concentrates. A second shaft was sunk and other development work done. Other mines operating in the vicinity of Harrison were the Annie May and the Joplin mines on Crooked Creek, the latter making a fair production of high-grade blende concentrates.

Kingdon Springs district.—The Erie-Ozark Mining Company, after prospecting, developed an ore body at 120 feet, to work which a second-hand mill was moved from the Joplin district and set up just at the close of the year. The Monkey Hill mine was operated for a very brief time; the Onwatta and Big Star mines were not in operation at all during the year.

Maumee district.—The North Arkansas Mining and Investment Company operated the Maumee mine for a short time only, and made a small output of blende ore. The Jack Pot Mining Company began the remodeling and rebuilding of the old Jack Pot mill. The mill, enlarged to 100 tons capacity, was completed early in 1909. The North Star mine was not in operation during the year.

Mount Hersey district.—The Hurricane Zinc Company, operating the Big Hurricane mine, maintained its record as a large producer of zinc carbonate, though not in operation for the full year. The Belle of Wichita and the Spier mines were not in operation.

Rush Creek district.—The Morning Star Mining Company was in operation for a portion of the year and made a fair output of both blende and zinc carbonate concentrates. The Philadelphia, McIntosh, and Silver Hollow mines were not operating.

Zinc district.—Development work was pursued at the Lone Jack mine in Coon Hollow, and a small quantity of mixed silicate and blende was raised. The Madison mine was operated for a short interval and had a small output of zinc carbonate ore. The Almy and Gloria mines were not in operation during the year; ore is reported in a drill hole on this tract at a depth of from 285 to 335 feet. The Black Bear Land and Mining Company erected a 50-ton mill during the latter part of the year and made a test run. The ore is blende in a sheet formation at a depth of 85 feet. Considerable iron pyrites occurs with the ore.

Other districts.—A 150-ton mill was erected at the Bonanza mine, 3 miles north of Buffalo City, in the first half of the year, and a good production of blende concentrates was made. The Reynolds Mining and Development Company, operating in the Hall Mountain district east of Yellville, during the year was succeeded by the Blue John Lead and Zinc Company. The Lincoln Mining and Milling Company, operating the New Era mines near Smithville, was mostly engaged in development work. The Powhatan Zinc and Lead Mining Company completed a 200-ton mill near Smithville just at the close of the year and began operating early in 1909. The tract is prospected

by extensive drilling and 3 shafts, respectively 40, 110, and 183 feet in depth. Ore is reported in a drill hole at a depth of 272 feet. The Paymaster Zinc Company was absorbed by the Arbuckle Mining and Milling Company, and all development discontinued for the present on both properties. A good strike of blende is reported near the village of Morrow in the southwestern part of Washington County. The ore occurs at shallow depths in the cherts of the Boone formation.

SOUTHWESTERN ARKANSAS.

The occurrence of lead and zinc in southwestern Arkansas is uniformly in true fissure veins which cut across the quartzitic sandstone and slates and have a filling of quartz.

The Bellah mine, in Sevier County, 6½ miles west of Gilham, was worked to a depth of 160 feet. The vein carried galena and chalcopyrite in the upper portion, but zinc blende predominated in the lower portion. The mine has not been in operation for several years.

The Houseley Mining Company in 1907 discovered and prospected a group of lead veins, each about a foot wide, near Point Cedar, in Hot Springs County. Operations were temporarily discontinued in 1908, but work was again begun early in 1909. The best ore is reported to assay about 65 to 75 per cent of lead, 6 to 10 per cent of zinc, 1 per cent of copper, and to carry from 1½ to 3 ounces of silver and from 0.05 to 0.08 ounce of gold to the ton.

ILLINOIS.

By C. E. Siebenthal.

PRODUCTION.

The production of lead, zinc, and silver in Illinois in 1907 and 1908 is shown in the following tables:

Production of lead and zinc in Illinois, by districts, in 1907 and 1908.[a]

District.	Ores.				Metal content.			
	Lead concentrates, galena.		Zinc concentrates, sphalerite.		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Northern Illinois:								
Galena	171	$8,843	[b] 3,668	$86,850	136	$11,424	1,479	$139,026
Elizabeth and Sand Prairie	45	2,400	800	15,000	38	3,192	238	22,372
Total	216	11,243	4,468	101,850	174	14,616	1,717	161,398
Southern Illinois	359	13,435	.....	.....	225	18,900	.....	.....
State total	575	24,678	4,468	101,850	399	33,516	1,717	161,398
Total, 1907	1,117	61,628	2,530	37,728	830	87,980	737	86,966

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York.

[b] Including 70 tons of zinc carbonate (drybone).

Production of silver in southern Illinois, 1907–8.

Year.	Silver.		Lead concentrates, silver-bearing.	
	Quantity.	Value.	Quantity.	Ounces of silver per ton.
	Fine ounces.		*Short tons.*	
1907	2,852	$1,882	497	5.738
1908	2,051	1,087	359	5.713

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineralogical association and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

NORTHERN ILLINOIS.

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwest county of the State. The ores have the same structural relations as in the upper Mississippi district generally; that is, they occur disseminated through the limestone, or in openings in it called "crevices," "pitches," or "flats," depending on their attitude to the horizontal. These openings have in general an east and west trend, known as their range. The ore bodies are sometimes continuous for long distances along these ranges, which for that reason largely control the prospecting, both by shafts and by drilling. The ore deposits occur in the Galena limestone and in the upper part of the Plattville limestone, both of Ordovician age. The ores are galena, sphalerite, and smithsonite, though the latter is much less common now than formerly, when the deposits worked were mostly shallow and above water level. The galena is practically nonargentiferous, and the zinc ores are not known to contain cadmium. Iron pyrites are very commonly associated with the ores, frequently in such quantity as to necessitate roasting and magnetic separation. Some of the concentrating plants have calciners or roasters attached, and there is a custom roaster operated by the Joplin Separator Company at Galena.

REVIEW BY DISTRICTS.

Galena district.—This district includes the mines in the vicinity of Fever River from Mississippi River to the Wisconsin state line. Though one of the earliest localities to be mined for lead in the northwest, it still produces a small quantity of that metal, and has in recent years produced noteworthy quantities of zinc ore.

The Appleton-Galena Lead and Zinc Company opened another shaft and made additions to the concentrating plant which increased its capacity to 80 tons. A substantial gain was likewise made in the output of lead and zinc concentrates. The Northwestern Lead and Zinc Company operated for a short time only, limiting the output on account of low prices for ore. The concentrating plant was increased from 70 to 125 tons daily capacity. The company affiliated the Paragon Lead and Zinc Company, operating on adjacent land. The Vine-

gar Hill Zinc Company ran steadily through the year and had the largest individual output in the district. The Marsden Black Jack mine, one of the large producers of 1907, was closed down all the year. The Pacific Gold Company was not in operation, and about the middle of the year the mill was burned.

Among the companies engaged in development work and operating intermittently were the Drill Hole Mining Company, Eureka Lead and Zinc Company, Illinois Lead and Zinc Company, Ten Strike Mining Company, and the Weinschenk mine.

Other districts.—Outside of the Galena district but two companies operated in northern Illinois during the year. The Illinois Mining Company raised a small quantity of lead ore, which was cleaned on hand jigs. The Royal Princess Mining Company, operating on the site of the old "California diggings," made a large output of zinc blende from a depth of 290 feet.

SOUTHERN ILLINOIS.

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of lower Carboniferous age, and are the northern extension of the Kentucky-Illinois fluorspar district. The structural relations and the mineralogical association are similar to the deposits of western Kentucky and in striking contrast to those of northern Illinois. The ores occur in fissure veins, in association with jointing and faulting. The mines have been worked to depths of 300 and 350 feet without disclosing any decrease in the dimensions of the ore bodies. Dikes and sheets of lamprophyre and dikes of mica peridotite occur in the vicinity, but not in direct connection with the ore deposits. Galena is the most important metallic mineral. Formerly, and nearer the surface, large bodies of galena were worked, but it is at present produced incidentally in the concentration of the fluorspar.

The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, the silver content ranging up to 12 and 14 fine ounces per ton of lead concentrates, and averaging for each of the last two years 5.7 fine ounces per ton of lead concentrates. Sphalerite or zinc blende is the next important metallic mineral, but it occurs much less plentifully than galena. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc. None has been sold from southern Illinois in the last two years. The principal vein minerals are fluorspar, calcite, and barite.

As the district is not reached by railway, the product of the mines is dependent on river transportation. The extreme low water in Ohio River for the last four months of the year 1908 was a hindrance to production.

There are 7 fluorspar concentrating mills in the district, ranging in capacity from 15 tons to 75 tons, all but 1 of which also recover more or less lead concentrates. They are generally equipped with jigs and concentrating tables. The proportion of lead concentrates to fluorspar concentrates varies with the different mines from 1½ per cent to 8 per cent. Reckoned by the quantity of fluorspar and lead

concentrates produced, a 20-ton mill working on the vein fluorspar of this district is equivalent to a 100-ton or a 200-ton mill in the Joplin region.

The Fairview Fluor Spar and Lead Company operates on the Good Hope vein, which was opened in 1862, the first actual mining in the district. At that time the lead alone was saved, the fluorspar being thrown on the waste heap, from which it was afterwards taken and sold. The workings reach a depth of about 300 feet, and are practically continuous northward to the Rosiclare shaft. The concentrating plant has a capacity of 75 tons. For 1908 the production of lead, as reported by the company, was the largest in the district, though considerably reduced from the figure reached in 1907.

The Rosiclare Lead and Fluorspar Company also operates the Good Hope vein, or one very near it, the ore body being continuous with that in the Fairview mine. The workings have reached a depth of 350 to 400 feet, and the mine has probably the longest record of continuous production of any in the district. The mill has a capacity of about 60 tons.

The Cave-in-Rock Mining and Milling Company produced considerable lead concentrates; the mine is shallow, being worked at a depth of 40 feet; the mill has a capacity of 50 tons. The G. W. Robinson Lead and Spar Company operated during the year. The Hamp Fluorspar and Lead Company, operating 10 miles north of Elizabethtown, spent the year in development work, sinking a third shaft. The Evansville Lead and Spar Company was closed down during the whole year. The Compton Mining and Milling Company is operating the Mary mine near Bay City, Pope County.

IOWA.

By C. E. Siebenthal.

PRODUCTION.

The production of lead and zinc in Iowa in 1907 and 1908 is shown in the following table:

Production of lead and zinc in Iowa in 1907 and 1908, in short tons.[a]

District.	Ore.				Metal content.			
	Lead concentrates. Galena.		Zinc concentrates. Sphalerite.		Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Dubuque	63	$3,613	829	$23,183	51	$4,284	395	$37,130
Dubuque, 1907	304	22,023	303	8,577	242	25,652	145	17,110

[a] In calculating the metal content of the ore from assays, allowance has been made for smelting losses in the case of zinc but not in the case of lead. In comparing the value of ore and metal content it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York.

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles in Dubuque, Clayton, and Allamakee counties. They are found in the Galena limestone, of Ordovician age. The Dubuque mines were in early days the most important source of lead in the United States, and in later years the mines, especially those in the vicinity of Durango, yielded considerable quantities of zinc carbonate ore. Nearly all this earlier mining was done above water level, and only within the last few years has there been much attempt to mine below water level. Therefore, the production, particularly of zinc ore, for 1907 and 1908, though small, is noteworthy, since it marks the transition from shallow to deeper mining.

The ore deposits of the Dubuque district occur in crevices and in caves or "openings" along these crevices. Of these openings there are five or six, the "top," "middle," and "third" being the most prolific of ore. The "flats" and "pitches" common in the Wisconsin mines have been found in only one or two instances in Iowa. The crevices have an east-west trend, and sometimes extend considerable distances, being mined at different places, in which case they are known as "ranges." The mining operations of recent years have generally been confined to attempts to find paying ore at deeper levels in these old ranges which are known to have yielded ore in former days in the upper openings.

The low price of zinc ore during 1908 reduced the number of producing mines and prospects from 14 in 1907 to 7 in 1908. That the production for the latter year shows an increase over the former is due wholly to the greater output of the Avenue Top mine.

The Avenue Top Mining Company's shaft is on the hilltop in the western part of Dubuque, and the concentrating plant is on the river bottom in another part of the city, the ore being hauled from mine to mill in wagons. The mill has a capacity of 80 tons and is equipped with two 8-cell jigs. It was completed in October, 1907, and ran until September, 1908, when it was closed down under a receivership. During the early part of the year a promising lead prospect was opened on another range just north of the Avenue Top shaft and belonging to that company.

The Fitzpatrick Lead Mining Company built a mill in the Buena Vista district in the latter part of 1907, and made a short test run in 1908. The mill has a capacity of 100 tons daily and is equipped with a Trego roaster and Cleveland-Knowles magnetic separator of 25 tons capacity. No sales of ore were made, and the mine has not since been operated on account of the depressed price of ore. The underground workings show a crevice deposit with openings, the mining being at the 112-foot level. In times past the mine has yielded important quantities of lead. The ores at present comprise both zinc and lead.

A number of companies were engaged in prospecting or development work in which small quantities of lead or zinc ore were raised. Many of the mines and prospects temporarily suspended operations on account of the low prices of ore.

The cooperation of Prof. Samuel W. Beyer, of the Iowa Geological Survey, in the collection of statistics of the lead and zinc ore production of Iowa is cordially acknowledged.

KANSAS.

By C. E. Siebenthal.

PRODUCTION.

The production of lead and zinc in Kansas in 1907 and 1908 is shown in the following table:

Production of lead and zinc in Kansas in 1907 and 1908, by districts, in short tons.[a]

District.	Ores.								Metal content.			
	Lead concentrates.				Zinc concentrates.				Lead.		Zinc.	
	Galena.		Carbonate.		Sphalerite.		Carbonate and silicate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Galena	2,647	$140,428	.....	.....	17,925	$569,371	395	$4,414	2,073	$174,132	8,704	$818,176
Badger-Peacock	514	27,515	.....	.....	10,353	355,795	.....	.....	411	34,524	5,294	497,636
Playter	44	2,284	.....	.....	246	7,480	.....	.....	34	2,856	121	11,374
State total	3,205	170,227	.....	.....	28,524	932,646	395	4,414	2,518	211,512	14,119	1,327,186
Total, 1907	3,192	182,603	8	$303	35,871	1,444,723	94	489	2,555	270,830	17,772	2,097,096

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York.

The lead and zinc deposits of Kansas, so far as developed, are limited to the southeastern portion of the State, in Cherokee County. They comprise the western extension of the ore deposits of the Joplin region and display the general characteristics of that area, except that here typical sheet ground deposits have not been extensively developed. The ores are galena and lead carbonate, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, carrying but a small fraction of an ounce of silver to the ton of lead concentrates. The industrial depression continued to affect production in this area seriously. Ore strikes in drill prospecting were reported during the year from Opolis, 2 miles south of Pittsburg; from Keelsville, 12 miles west of Baxter Springs, and elsewhere; but in no case as yet have they been proved by sinking a shaft. These places are all within the area of Pennsylvanian shale and many miles from known deposits. The workable ore bodies have so far been found in the Boone formation, but, as noted elsewhere, recent discoveries show the existence of ore in the Kinderhook rocks underlying the Boone. Both are of lower Carboniferous age.

REVIEW BY DISTRICTS.

Badger-Peacock district.—Developments on the Hubbard land extended the district limits westward, and drilling on the Ellis and Claiborne land is reported to have struck ore a half mile north of the present limits of mining. Among the important producers were the Hubbard Mining and Milling Company and the Badger Mining and Milling Company.

At Peacock, on the east side of Spring River, the land controlled by the United Zinc Companies made a large production, though considerably reduced from that of 1907. The subleasing companies operate 7 concentrating plants with an aggregate capacity of 825 tons, not counting tailings and sludge plants.

Playter district.—The ore body worked by the Newton Zinc Company and the Kress Mining Company on the Playter lease is shallow, reaching from near the surface down to 40 or 60 feet. It is mined by the open-cut method, and the workings have reached a depth of 60 feet in places. The Kress Mining Company's plant was not worked during 1908, but the Newton Zinc Company was in operation for part of the year.

Several old shafts and prospects on the west side of Spring River, a mile or so south of Playter, were reopened, and some production was made from the Carter land.

Galena district.—Though the 1908 production of the Galena district fell off somewhat from that of 1907, several developments took place which augur well for future production. A number of rich strikes of "shallow lead" were made within the city limits in territory which has been worked for many years. New productive territory was discovered southwest of Galena near Shoal Creek. A plan was materialized to drain the Short Creek bottom, the old workings in which have been flooded since the washing away of the Short Creek flume during high water, a number of years ago. As the ground was yielding richly at shallow levels when flooded, it will, no doubt, again add to the production of the district. What promises to be a very important development of the year was the discovery of deep ore in drilling the Robertson and Ping tracts, 2 miles north of Galena. The ore was found below the Grand Falls chert member of the Boone formation at what appears to be about the same horizon as that at which the ore body occurs in the Herald mine at Cave Springs. More recently ore is reported to have been struck in the same rocks on the Murphy land at Empire. The fact that these three occurrences are situated in a triangle, each about 2 miles from the others, offers encouragement to hope that the deposits at this horizon may develop considerable extent. A large shaft is being sunk on the division line of the Robertson and Ping tracts, and, if results justify, a double mill will be built, a unit for the ore of each tract.

The Southside Mining Company made the largest production of the district, both of zinc blende and lead. The mining on this tract is at various depths above 100 feet. Four shafts, sunk to a depth of 170 feet, are reported to have struck sheet or blanket-vein ore in the Grand Falls chert member, the same horizon as that of the sheet ground farther east.

The Bonanza Lead and Zinc Company also made a large production of zinc ore. This ground was reopened in 1907, after a shutdown of several years, and is again one of the chief producers of the district. Three mills of 100 tons capacity each are operated. The New Century Zinc and Lead Mining Company reported a good production of zinc and lead ores, the output of two subleasing companies. Other companies reporting a large output were the Lockport Mining Company, the Latawanna Mining Company, the Illinois Lead and Zinc Company, J. S. Oglesby & Co., and the Hoosier Mining Company. The tailings and sludge mills having a large output were C. W. Squires, W. N. Squires, and Murphy, Friel & Co.

KENTUCKY.

By C. E. Siebenthal.

PRODUCTION.

Lead and zinc deposits are found in central Kentucky and western Kentucky. The majority of the mines in both these regions were either idle during 1908 or engaged in development work, owing to the financial depression and to the consequent dullness of the fluorspar market. No sales of ore were reported for the year. In 1907 the production amounted to 54 tons of lead concentrates, valued at $2,850, from which there was recovered 103 fine ounces of silver, valued at $68.

CENTRAL KENTUCKY.

The ore deposits of this district are in Mercer, Scott, Franklin, Owen, Henry, and adjoining counties, in rocks of Lower Ordovician age. The ore, mostly lead, occurs in veins associated with such gangue minerals as barite, fluorite, and calcite. In some instances the lead has been obtained incidental to the mining of these minerals. No production of lead from the district was reported in either 1907 or 1908, though some lead ore was mined and stored during the latter year.

The Mutual Mining Company operated in Franklin County, the deposit consisting of a fissure vein 6 feet in width which has been followed to a depth of 180 feet. The ore is barite with a small proportion of lead. The concentrating and smelting plant is located near Stamping Ground. The mill has a daily capacity of 40 tons. The lead concentrates produced during 1908 were stored, and attention was directed to the production of barium sulphate (blanc fixe) and sodium sulphide.

In Owen County the Ohio Lead Mining Company has at Gratz a good concentrating plant and has mined some lead ore. Lead only has been recovered, the barite tailings going to the waste pile. The vein, from 6 inches to 6 feet in width, has been followed vertically to a depth of 400 feet, and laterally for 1,000 feet, work being carried on at 3 levels. After much experimentation a chemical plant has been designed to treat the barium and to save the lead as a by-product.

Southward across Kentucky River, in Henry County, the Union Mining Company and the Lockport Lead Mining Company have worked on the same vein of barite and galena, here from 1 to 2 feet in

width. According to report the same vein is traceable northward 7 miles to Twin Creek, where prospects have been opened. Lead has also been mined from the Johnson vein in Scott County and the Clark vein in Franklin County.

WESTERN KENTUCKY.

The lead and zinc deposits of the western or fluorspar region of Kentucky are found chiefly in Caldwell, Crittenden, and Livingston counties, but continue northward across Ohio River, forming the southern Illinois lead and zinc region, and also southward in occasional deposits into western Tennessee. The ore deposits occur principally in the Chester and Meramec groups, of lower Carboniferous age. The ores are galena, sphalerite, and smithsonite, and occur in association with such gangue minerals as fluorspar, barite, and calcite. The sphalerite and the smithsonite are in many cases cadmium-bearing, and the lead is argentiferous. From the lead concentrates shipped in 1907 there were recovered 103 fine ounces (troy) of silver, an average of 1.9 ounces to the ton of concentrates. The silver content ranges from a very small quantity to over 3 ounces per ton.

The ores occur in veins, in breccias, and as metasomatic replacements, all within or adjacent to zones of faulting. In several mines and prospects the ore occurs in contact with or adjacent to dikes of mica peridotite. Considerable quantities of both lead and zinc ores have been produced in the past, but at the present time they are produced as by-products in the recovery and concentration of fluorspar, which is the principal economic mineral. According to a recent report of the Kentucky Geological Survey there are in the district 10 plants for the concentration of fluorspar and for the separation and saving of lead and zinc concentrates. These are in the main similar to the smaller mills of the Joplin region, but adapted to local needs by the addition of grinding machinery and concentration tables.

No sales of either lead or zinc ores from western Kentucky were reported for 1908, though several companies engaged in prospecting and development work stored some lead and zinc ore. Prospects are good for a much increased production in 1909.

The Kentucky Fluorspar Company, of Marion, stored all lead ore saved during the year. The Albany Mining and Investment Company's shaft was sunk from 240 feet to 310 feet, where the vein of fluorspar carrying some lead is reported to be 16 feet wide. The Blue Grass Fluorspar Company erected a grinding mill and raised some lead and zinc ore incidental to the output of fluorspar. The Great Northern Mining and Milling Company is prospecting on the Columbia vein near Marion and has two shafts in ore—fluorspar carrying considerable lead—one 90 feet and the other 200 feet in depth. The Kentucky and Indiana Mining Company, operating 9 miles southwest of Marion, found intermingled fluorspar, lead, and zinc blende from a depth of 100 feet to 115 feet. The Sunnybrook Lead and Fluorspar Company, working a fissure vein containing fluorspar with disseminated lead at 220 feet, is sinking 100 feet farther.

MICHIGAN.

By B. S. Butler.

PRODUCTION.

In 1908 the mines of Michigan produced 223,286,700 pounds of copper, valued at $29,473,844, and 241,055 fine ounces of silver, valued at $127,759; a total value in copper and silver of $29,601,603. This is a decrease in value of $14,149,687, or about 32 per cent, from the production of 1907. This decrease in the value of mineral output is due to the lower prices for both metals in 1908, although the production of copper in 1908 showed a slight increase by weight, while that of silver was somewhat smaller than in 1907. For 1907 the average price of copper was $0.20 and for 1908 it was $0.132; the average price of silver for 1907 was $0.66 per fine ounce and for 1908 it was $0.53. Owing to the slight decrease in copper content of rock treated and to the marked falling off in price of both copper and silver, the average value per ton of rock decreased from $4.42 in 1907 to $2.81 in 1908. The following table shows the average values in copper and silver of rock treated in 1907 and 1908:

Value of silver and copper product of Michigan mines in 1907 and 1908.

Year.	Silver.	Copper.		Combined silver and copper.
	Value.	Value.	Value per ton of rock.	Total value.
1907	$197,844	$43,553,446	$4.40	$43,751,290
1908	127,759	29,473,844	2.79	29,601,603
Decrease	70,085	14,079,602	1.61	14,149,687

The entire Michigan output of copper and silver is from the Keweenaw district. Both metals occur native in lodes remarkable for their great extent and uniformity. These lodes may be divided into two general classes: The amygdaloid, in which the metals occur in the cellular portions of lava flows, and the conglomerate, in which the metals cement and to some extent replace the pebbles forming the conglomerate. Native copper and copper minerals occur in fissures in the district, but at the present time the output from this type of deposit is of little importance. The rock[a] is of low grade and requires milling, which produces "mineral" carrying an average of 65 per cent copper. A small amount of "barrel" and "mass" copper is sorted at the mines and sent direct to the smelters.

In 1908 there were 10,531,271 tons of rock milled, which yielded 339,233,252 pounds of "mineral" and 223,286,700 pounds of copper.[b]

[a] Some of the terms used to designate the different materials entering into the mining industry differ for the Lake district from those employed in any other part of the country; ore is known as "rock" or "copper ground" (if unmined); the product of concentration is known as "mineral;" the term "ore" is used to designate the copper minerals (arsenides, sulphides, etc.) that occur to a limited extent in the district. Large bodies of native copper are known as "mass" and smaller ones are designated as "barrel work."

In this report the local terms will be used, as it does not seem desirable to employ the more usual terms to the exclusion of the local, while a mixture of the two is confusing.

[b] The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during 1908.

The recovery of refined copper per ton of rock milled in 1908 was 21.2 pounds as compared with 22 pounds in 1907. This decrease is much less than in 1907, when the recovery fell from 25.2 pounds per ton in 1906 to 22 pounds in 1907.

There were 3,595 ounces of silver recovered as "pickings" and the remainder, 237,460 ounces, was derived from the electrolytic treatment of 26,786,485 pounds of copper. This electrolytic copper was recovered from approximately 1,494,339 tons of rock, an average of 0.1589 fine ounce of silver per ton of rock. The 3,595 ounces of silver "pickings" were recovered from mines producing 561,866 tons of rock, an average of 0.006 fine ounce of "pickings" per ton of rock. The "pickings" represent but a small percentage of the silver content of the rock, the remainder going into the copper.

The following table shows the production of metal, "mineral," and rock in Michigan for 1907 and 1908:

Production of silver, copper, "mineral," and "rock" in Michigan in 1907 and 1908.

Year.	Silver.	Copper.			"Mineral."		"Rock."
	Quantity.	Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Lbs.*	*P. ct.*	*Pounds.*	*P. ct.*	*Tons.*
1907	299,764	217,767,232	22.0	1.10	341,578,292	63.75	9,892,214
1908	241,055	223,286,700	21.2	1.06	339,233,252	65.82	10,531,271
Increase (+) or decrease (−).	−58,709	+5,519,468	−.8	−.04	−2,345,040	+2.07	+639,057

The following table shows the relative importance of the amygdaloid and conglomerate rock in 1907 and 1908. The most significant facts brought out are the continued decrease in the copper derived from conglomerate and in copper content of the conglomerate. The relative proportion of the conglomerate and amygdaloid rocks milled during the last two years did not change. The copper derived from conglomerate dropped from 41.4 per cent in 1907 to 39.3 per cent in 1908, and the yield per ton of rock from 33.9 in 1907 to 30.9 in 1908. No silver was reported as derived from conglomerate in 1908.

Production of "rock" and "mineral" and yield in silver and copper in Michigan, in 1907 and 1908, by kinds of rock.

	1907.		1908.	
	Amygdaloid rock.	Conglomerate rock.	Amygdaloid rock.	Conglomerate rock.
Silver:				
Fine ounces	288,594	11,170	241,055	.....
Per cent of total	96.5	3.7	100	.....
Average yield per ton of ore.....ounce..	0.040	0.002	0.031	.....
Copper:				
Pounds	127,602,718	90,164,514	135,604,144	87,682,556
Per cent of total	58.6	41.4	60.7	39.3
Average yield per ton of rock.....pounds..	17.7	33.9	17.6	30.9
Average yield, per cent	0.88	1.69	0.88	1.54
"Mineral:"				
Pounds	185,486,312	156,091,980	193,839,568	145,393,684
Per cent of total	54.3	45.7	57.1	42.9
Average yield in copper.....per cent..	68.7	57.7	69.9	60.3
'Rock:"				
Tons	7,232,994	2,659,220	7,694,994	2,836,277
Per cent of total	73.1	26.9	73.1	26.9

Three counties, Houghton, Keweenaw, and Ontonagon, contributed to the output of copper and silver in 1908. The following table shows the relative importance of these counties in output of copper and silver for 1907 and 1908. It may be noted that the decrease in silver is not due to a decrease in the silver content of the rock, but that less copper was electrolytically treated in 1908 than in 1907. The decrease in copper recovered per ton of rock milled is confined to Houghton County and can be attributed largely to the decrease in recovery from conglomerate rock.

Production of silver and copper in Michigan for 1907 and 1908, by counties.

1907.

County.	Silver.	Copper.			Concentrates.		"Rock."
	Quantity.	Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine oz.	*Pounds.*	*Lbs.*	*P. ct.*	*Pounds.*	*P. ct.*	*Tons.*
Houghton	297,296	191,954,611	23.6	1.18	305,619,887	62.8	8,120,981
Keweenaw	497	18,595,931	15.8	.79	25,163,445	73.9	1,176,247
Ontonagon	1,971	7,216,690	12.1	.60	10,794,960	66.8	594,986
Total	299,764	217,767,232			341,578,292		9,892,214
Average			22.0	1.10		63.75	

1908.

Houghton	237,692	197,332,438	22.3	1.11	304,755,607	64.7	8,838,014
Keweenaw	595	19,806,216	16.3	.81	26,209,977	75.5	1,213,071
Ontonagon	2,768	6,148,046	12.8	.64	8,267,668	74.4	480,186
Total	241,055	223,286,700			339,233,252		10,531,271
Average			21.2	1.06		65.8	

REVIEW BY COUNTIES.

In the following reviews of the operations at the individual mines of the district during 1908 the statements concerning the quantity, character, and tenor of rock developed, the quantity of rock stamped, the copper recovered per ton of rock stamped; and the cost of production are based on the published reports of the companies. In the few cases where reports are not published a general statement of the character of operations is made from the best information available.

HOUGHTON COUNTY.

In 1908 the mines of Houghton County produced 197,332,438 pounds of copper and 237,692 ounces of silver, or 88.4 per cent of the copper and 98.6 per cent of the silver output of Michigan. The county occupies the central portion of the copper belt and contains 11 of the 20 mines that contributed in 1908 to the copper output and 4 of the 6 mines that produced silver.

The details of the production for 1907 and 1908 are shown in the following table:

Production of rock and mineral and average yield in silver and copper in Houghton County in 1907 and 1908, by kinds of rock.

	Amygdaloid rock.		Conglomerate rock.		Total and average.	
	1907.	1908.	1907.	1908.	1907.	1908.
Silver:						
Fine ounces	286,126	237,692	11,170	.....	297,296	237,692
Per cent, county total	96.2	100	3.8	.....	100	100
Copper:						
Pounds	101,790,097	109,649,882	90,164,514	87,682,556	191,954,611	197,332,438
Per cent, county total	53.0	55.6	47.0	44.4	100	100
Average yield per ton of rock, pounds	18.6	18.2	33.9	30.9	23.6	22.3
Average yield, per cent	0.93	0.91	1.69	1.54	1.18	1.11
"Mineral:"						
Pounds	151,527,907	159,361,923	156,091,980	145,393,684	305,619,887	304,755,607
Average yield, per cent	67.2	68.8	57.7	60.3	62.8	64.7
"Rock:"						
Tons	5,461,761	6,001,737	2,659,220	2,836,277	8,120,981	8,838,014
Per cent, county total	67.2	67.9	32.8	32.1	100.0	100.0

The county shows an increase of 5,377,825 pounds of copper and a decrease of 59,604 fine ounces of silver. This decrease in silver, as already stated, is due to the decrease in the quantity of copper that was electrolytically refined rather than to any change in silver content of the rock. Although the great conglomerate lode continues to decrease in copper content, yet the developments on the amygdaloid lodes have thus far more than compensated for this loss, and promise to keep the county up to a high state of productiveness even after the exhaustion of the "Calumet" conglomerate lode.

Calumet and Hecla.—The Calumet and Hecla Company is one of the most successful copper-mining companies in the world, not only as to copper output and dividends paid, but also as regards the uniformly high grade of the copper produced and the development of mining and milling methods on an immense scale.

The company's grounds contain three copper-bearing lodes, the "Calumet" conglomerate, the "Osceola" amygdaloid, and the "Kearsarge" amygdaloid. The immense production of the mine in the past has come chiefly from the conglomerate, but with the decrease in copper content and the approaching exhaustion of this famous lode the company has developed mines in the amygdaloids.

The conglomerate lode is opened for a distance of nearly 2 miles along the strike by 10 inclined shafts and 1 vertical shaft, with an aggregate of about 200 miles of opening.

The inclined shafts vary in depth on the dip from 4,000 to 8,100 feet, with a maximum vertical depth of 4,850 feet. The Red Jacket vertical shaft has a depth of 4,900 feet. The lode in the "Five Forties" tract, extending north from the company's main holdings, is being developed by a blind shaft which starts 1,500 feet east of the Red Jacket vertical near the bottom of Calumet No. 4 and extends north parallel with the lode and about 25 feet below the foot wall. This will develop four of the five 40-acre tracts; the fifth will be developed by a subshaft from this. A drift in the foot wall connects this shaft with the Red Jacket vertical on the fifty-seventh level. The blind

shaft is sunk on an incline of 22°; this will permit the hoisting of the rock in tram cars, which will be hauled to the bins on the fifty-seventh level of the Red Jacket shaft for hoisting. The developments thus far in this tract have been encouraging.

The shafts on the lode near the southern boundary of the property are bottomed in poor ground, and the shafts and pillars are being drawn preparatory to abandonment.

It was reported early in 1909 that a shoot carrying good values had been discovered under South Hecla shafts No. 9–10 at the seventy-third level. The importance of this discovery is yet to be demonstrated. Several areas served by the other shafts are nearly worked out and will soon be abandoned.

In the latter part of 1907 it was estimated by the management that the mine contained probably 20,000,000 to 25,000,000 tons of profitable rock, which, at the rate of production then in force, would last ten to fifteen years.

The conglomerate lode increases in width with depth from about 13 feet at the outcrop to about 20 feet in the deepest workings; the rock decreases in richness with depth, however, and the recovery per ton has been constantly falling off, till for the fiscal year ending April 30, 1909, it is stated to have been about 35 pounds per ton. In the upper workings the rock was very rich, running as high as 100 pounds per ton, and the rock treated from the lode has probably averaged above 60 pounds per ton. A part of the decrease in richness is undoubtedly due to the improvement in mining and milling methods, which make it possible to treat rock that could not be handled in the early days of operation.

The Osceola lode is opened by 6 inclined shafts, those at the south, having reached the twenty-third level, while the most northerly begun in 1907, is down several hundred feet in good ground. The lode is opened for about half its length of 11,000 feet on Calumet and Hecla ground by upward of 24 miles of lateral workings. This lode has an average width of from 30 to 35 feet, though mineralization is confined principally to the hanging and foot walls. The lode is opened by "drift stopes" along the hanging wall, where the workable rock is 8 to 10 feet thick. Most of the production since 1904 has come from the "drift stopes," and the output of the mine could be greatly increased if the stoping ground opened up were to be drawn upon. About 15,000,000 tons are now developed in this lode.

For the fiscal year ending April 30, 1909, this lode produced 747,378 tons, yielding the equivalent of 12,722,226 pounds copper, or about 17 pounds per ton.

The Kearsarge lode is opened by 3 shafts with a maximum depth of 1,300 feet. The ground thus far opened on this lode is somewhat erratic, though considerable stretches will probably yield fair values. As yet this lode has made but small production.

The concentrating mill at Lake Linden, 4 miles from the mine, is equipped with 28 single expansion heads, 23 for conglomerate rock and 5 for amygdaloid, with the necessary jigs, classifiers, tables, etc., for treating 10,000 tons of rock per day.

The regrinding plant, partly completed in 1908, is to be equipped with 48 Chilean mills and 200 Wilfley tables, capable of treating 1,500 tons daily. Twenty-four of the Chilean mills were installed during the year, and the remaining 24 will probably be in operation before

the close of 1909. This plant is designed to treat a part of the tailings from the stamp mill. Four pounds of copper are extracted from a ton of tailings at a cost of about 5 cents per pound.

The smelting works are located at Hubbell on Lake Linden, and at Black Rock, Buffalo, N. Y. The Hubbell plant is equipped with 11 reverberatory furnaces and blast furnace and mineral houses, with a capacity of 18,000 tons. The Buffalo plant is equipped with reverberatory and blast furnaces and an electrolytic plant. The latter is being enlarged. The copper high in arsenic or silver is electrolytically refined at this plant.

Tamarack.—The Tamarack ground lies northwest of the Calumet and Hecla and its operations are conducted on the underlays of the "Calumet" conglomerate and the "Osceola" amygdaloid. Both lodes enter the property at considerable depth and are reached by vertical shafts, the different levels being connected with these shafts by crosscuts. The property is opened by 5 shafts, varying in depth from 3,409 feet (No. 1) to 5,253 feet (No. 3), the latter having the distinction of being the deepest shaft in the world.

The company, although at a disadvantage on account of the great depth of the mine and the consequent high mining costs, has made a good records in dividends, which between 1888 and 1908 aggregated $9,420,000. At present efforts are being made to reduce the cost of production, which, in 1908, was 15.24 cents per pound, and at the prevailing price of copper resulted in a net loss. A part of this cost, however, was in the nature of permanent improvements and developments.

All the shafts are now connected by underground workings, which greatly improves ventilation. During the year the preparation for pumping the water from the vicinity of shafts Nos. 1, 2, and 5 through No. 1 were nearly completed. This will leave Nos. 2 and 5 free for the hoisting of rock. The mechanical hauling system is extensively installed in the mine. To reduce the cost of timbering the company has followed the plan of extending drifts to the boundary before beginning stoping and then allowing the stopes to close as the rock is removed. This is especially important, as the great depth renders it very difficult to keep the stopes open.

During the year No. 1 shaft was put in condition to handle the water for the southern part of the mine. A Nordberg cross-compound pumping engine with a capacity of 500 gallons per minute is being installed at the 900-foot station and one of equal capacity is to be installed at the 500-foot station. This will care for the surface water and save the expense of hoisting it from the deep levels of the mine, and, as already said, will leave shafts Nos. 2 and 5 free for the hoisting of rock.

At No. 2 shaft the "Osceola" amygdaloid was developed on levels 18 to 25, inclusive. In the development drift stopes are extended to the boundaries before stoping is begun. The drifts on the eighteenth level reached the boundary during 1908 and those on the nineteenth, twentieth, twenty-first, twenty-second, and twenty-third levels should reach the north boundary during 1909. This will give extensive stoping ground on this lode. On the conglomerate lode mining was carried on from the twenty-fourth to the thirtieth levels. The shaft is being put in shape for the installation of Kimberly skips to handle the increased tonnage from the Osceola lode.

No. 5 shaft was sunk 67 feet to a depth of 5,156.5 feet during the year. New developments were on the thirty-ninth and fortieth levels, where some medium stoping ground was proven.

At No. 3 shaft new openings on the seventeenth and eighteenth levels have shown excellent rock. An inclined shaft was started from the thirteenth level to follow the dip of the lode. It will be operated by an underground hoist and is expected greatly to reduce the costs.

At No. 4 shaft a new shaft house and head frames were erected.

During the year the Lake Superior waterworks were doubled in capacity, extensive repairs were made to the coal dock, and the stamp mill was completed.

The yield of refined copper per ton of rock stamped decreased from 20.8 pounds in 1907 to 19.6 in 1908. This, however, was partly due to the increase in the quantity of rock from the Osceola lode, a part of which was low grade. The cost per pound of copper, however, was reduced from 16.66 cents in 1907 to 15.24 cents in 1908. Whether copper can be profitably produced from this mine at prices as low as those prevailing during 1908 is a matter yet to be determined.

Osceola.—The Osceola Company operated the three branches—the Osceola, the South Kearsarge, and the North Kearsarge—during 1908. The year was one of the most successful in the history of the company.

In 1908 there were 21,250,794 pounds of refined copper produced, as compared with 14,134,753 pounds in 1907. In 1908 there were 1,241,400 tons of rock stamped, against 811,603 tons in 1907. The rock showed a slight decrease in copper recovered per ton of rock stamped; in 1907 the recovery was 17.4 pounds per ton; in 1908 it was 17.11 pounds. A very decided reduction in the cost of producing a pound of copper was accomplished; in 1907 this was 12.44 cents; in 1908 it was 10.53 cents.

The Osceola lies directly south of the Calumet and Hecla and is worked on the "Osceola" amygdaloid. The property contains the Calumet and Hecla lode, but the only portion of this in Osceola ground that has been shown to carry copper in paying quantities was worked out in the early days of the mine. Shaft No. 5 was sunk 147 feet during 1908 to a depth on the slope of 4,456 feet, and No. 6 was sunk 66 feet to 4,408 feet. Drifting was carried on from the thirty-third to the forty-fifth levels to the extent of 4,804 feet. The copper content of the rock developed in the early months of the year was not up to the average, but showed decided improvement later. The reserves of copper-bearing ground are large, and developments are well ahead of stoping requirements.

The South Kearsarge lies south of the Wolverine and east of the Centennial on the Kearsarge lode. Shaft No. 1 had a depth of 2,604.5 feet on the slope, and No. 2 a depth of 1,992.5 at the close of the year. During the year 12 drifts reached the boundary, and the mine can be completely developed in another year. The North Kearsarge lies north of the Wolverine and is working in the Kearsarge lode. Shaft No. 1 had a depth of 3,873.5 feet, No. 3 a depth of 3,192 feet, and No. 4 was sunk 754 feet during the year to a depth of 916 feet. As crosscuts from this shaft will connect with drifts from No. 3, it will be in shape for a considerable production before the close of 1909. During 1908 drifting to the extent of 6,997 feet was accomplished on the various levels from the sixth to the thirty-fourth. A large amount of ground is developed, and the mine is in a position to continue a large output for years.

The mill had a very successful year, stamping 1,426,339 tons of rock at a gross cost of 15.779 cents per ton.

Centennial.—The Centennial ground lies north of the Calumet and Hecla and west of the South Kearsarge and the Wolverine. It contains the Calumet and Hecla, Osceola, and Kearsarge lodes, the latter being the only one of proved value in the property, and to this lode operations are at present confined.

During the year shaft No. 1 was sunk 93 feet to 3,624 feet, and No. 2 was sunk 403 feet to 3,550 feet. There were 3,756 feet of drifting done during the year. A large part of this consisted in extending the lower levels of the mine to the north where the improvement noted in 1907 was continued. The rock treated during 1908 yielded 19.76 pounds per ton, or 1.08 pounds better than in 1907. The rock treated early in 1909 showed even better values.

The Lake Milling, Smelting, and Refining Company, at Grosse Point on Portage Lake, operated in conjunction with the Allouez Company, is increasing its capacity by the installation of 2 new compound heads.

Wolverine.—The Wolverine is located between the North and the South Kearsarge branches of the Osceola Company. Its operations are on the "Kearsarge" amygdaloid, though the West lode, parallel with the Kearsarge lode and about 80 feet to the west, has been opened to a small extent. The mine has the distinction of having the richest amygdaloid, and, next to the "Calumet" conglomerate, the richest rock mined in the district. The lode is opened by 4 shafts, numbered from 1 to 4 from north to south. No. 1 is abandoned; No. 2, bottomed at the boundary at a depth of 1,700 feet, is used for handling men and supplies; No. 3 at the close of 1908 is bottomed at the twenty-fifth level, but can be sunk to a depth of 4,300 feet before reaching the boundary; No. 4 is bottomed at the thirtieth level. The lode in the Wolverine ground shows great uniformity of mineralization and is opened for the full length. In the upper levels the rock averaged from 16 to 18 pounds per ton, but as the lower levels were opened it showed marked improvement, the average for the fiscal year 1908 being 26.82 pounds per ton. The mine has ore blocked out well ahead of stoping requirements and an assured output at the present rate for years to come.

During the fiscal year 1908 the mill at Traverse Bay stamped 348,860 tons of rock, yielding 12,117,000 pounds of mineral and 9,356,123 pounds of fine copper, or 26.82 pounds of fine copper per ton of rock stamped. The average cost of copper for this period was 7.321 cents per pound, the lowest of any copper mine in the district.

Franklin.—The Franklin property consists of two tracts—the Old Franklin, practically surrounded by the Quincy, and the Franklin Junior, south of the Rhode Island. The Old Franklin is nearly worked out, and during the year was sold to the Quincy Company. From the first of the year to December, when it was turned over to the Quincy Company, the Old Franklin produced 65,059 tons of rock yielding 17.22 pounds of copper per ton at a cost of 10.5 cents per pound.

The Franklin Junior operated during the year on the "Pewabic" amygdaloid and the "Allouez" conglomerate. It was determined, however, to cease opening on the latter and to confine development to the Pewabic lode. On the amygdaloid lode, 2,511 feet of drifting

opened good stoping ground, the results being especially favorable in the openings from the twentieth to the twenty-fourth levels. Extensive development has been confined to the hanging lode, though crosscuts have been made to the foot lode at the twenty-third, twenty-fourth, and twenty-fifth levels, where it shows copper.

During the year 279,416 tons of rock were stamped and produced 2,619,133 pounds of refined copper, or about 9.6 pounds per ton, at a cost of $1.48 per ton of rock.

Quincy.—The Quincy mine is situated just north of the east-west arm of Portage Lake and derives its principal output from the Pewabic lode, with a small quantity from the West lode. At the close of 1908 this mine had a record of forty years of operation without missing a yearly dividend. The production of 20,600,361 pounds of copper in 1908 is the largest output the Quincy has made, and its reserves are reported to be the largest in the history of the mine. The Pewabic lode is opened by 4 deep shafts, the deepest being more than 5,500 feet. The development work of the year of nearly 6 linear miles developed copper ground of about the usual quality.

The new Pontiac shaft was down about 200 feet at the close of 1908, and showed good copper rock. About 2 tons of "mass" copper were produced in sinking the last 125 feet. The precautions to avoid caving in the abandoned stopes and the resultant "air-blasts" appear to have met with success, as no serious trouble from this cause was experienced in 1908.

During the year a new rock house was built at No. 2 shaft, which made this the shaft of largest capacity on the property. Extensive repairs were also made to the railroad and the mill.

The Old Franklin mine was purchased late in the year, and immediately shut down. The remaining ground in this property can be readily reached through the Quincy workings.

In the early days of the mine "mass" copper formed a large percentage of the output, immense masses being encountered in the upper levels of the mine. Though this has decreased in the lower workings, "mass" copper still forms an important item in the output.

Isle Royale.—The Isle Royale mine is situated south of the east-west arm of Portage Lake, near Houghton. The property contains several copper-bearing lodes, of which Isle Royale is the main producer at present. Development was extensive during the year, including 1,802 feet of shaft sinking, 8,901 feet of drifting, and 130 feet of crosscutting. The Isle Royale lode is opened by 4 shafts, having depths at the close of 1908 as follows: No. 2, 2,597.5 feet; No. 4, 634 feet; No. 5, 580.5 feet; No. 6, 713 feet. No. 2 shaft was sunk 199 feet to the twenty-fifth level, and 5,033 feet of drifts and drift stopes were opened during the year. The openings north of the shaft were in poor ground, but those to the south developed rock well up to the average. A large proportion of the year's production was from this shaft. Shaft No. 4 was sunk 531 feet; all drifts on the lode from this shaft show better copper ground than the drifts from No. 2. No. 5 was sunk 417.5 feet and shows fair copper ground. No. 6 was sunk 344 feet in new ground, and for the entire depth the shaft is reported to be in copper rock. An extensive up-to-date surface plant was installed at this shaft during the year.

The Baltic exploration shaft was abandoned early in the year after sinking 812 feet and crosscutting without results.

In November, 1908, the "A" shaft was started on the south side of the Hussey-Howe tract and at the close of the year had reached a depth of 52 feet. A little copper has been found. A diamond drill core taken from the lode in this vicinity early in the year was well mineralized. This is thought to be the Baltic lode.

During the year improvements were made on the railroad and at the stamp mill preparatory to handling a larger tonnage of rock. The rock treated at the mill aggregated 218,940 tons, and produced 4,013,590 pounds of mineral, containing 75 per cent, or 3,011,664 pounds, of fine copper. The copper recovered per ton of rock treated decreased from 15.2 pounds in 1907 to 13.8 pounds in 1908.

Baltic, Champion, and Trimountain.—These three mines are located on the Baltic lode southwest of Houghton and are under the same management, that of the Copper Range Consolidated Company. The Baltic is an exceptionally strong lode, having a stoping width varying from 15 to 80 feet. The lode has produced considerable "mass" copper and also contains veinlets of copper minerals, including chalcocite, bornite, and copper arsenides. These minerals are recovered in the mill, and the arsenides probably account in part for the arsenical character of the copper range output. The mines are opened by steeply inclined shafts, the lode having a dip to the northwest of about 70°. In many cases it is found advantageous to mine the entire lode. The waste rock is sorted underground and built into dry walls, thus saving the expense of hoisting and serving the purpose of keeping the lode open better than timber and at a much less cost. During 1908 the Baltic operated 4 shafts, varying in depth from 1,349 feet to 1,723 feet at the close of the year. A total of 10,443 feet of drifting and 588 feet of crosscutting was accomplished. There were 764,117 tons of rock stamped, yielding 17,724,854 pounds of refined copper or 23.197 pounds per ton, at a cost of 7.72 cents per pound.

The Trimountain is also opened by 4 shafts, with depths varying from 1,319 to 1,881 feet at the close of 1908. During the year, the drifting amounted to 6,616 feet and the crosscutting to 562 feet. Developments on the sixteenth, seventeenth, and eighteenth levels of shaft No. 1 showed poor copper ground, though the lode is strong and well defined. In No. 2 shaft some good ground was developed in the fourteenth level; the fifteenth level has shown a little copper; and development was just beginning in the sixteenth level at the close of the year. There were 334,929 tons of rock stamped during the year, which yielded 18 pounds of copper per ton. The average cost of production for the year was 12.5 cents per pound.

The Champion, controlled jointly by the Copper Range Consolidated Company and the St. Mary's Land Company, like the two mines just described, is opened by 4 shafts, with depths varying from 1,519 feet to 1,685 feet. All the shafts are connected, and there are about 11 miles of underground workings. The lode is well mineralized in this mine, and the levels will probably be opened from end to end. During the year 10,216 feet of drifting and 385 feet of crosscutting were done. Rock amounting to 794,703 tons was stamped and yielded an average of 22.38 pounds per ton. The cost of production for the year was 8.34 cents per pound.

Exploration and development.—Aside from the regular producing companies already mentioned several companies were engaged in development work in the county; some of these will doubtless soon enter the producing class.

The La Salle mine, located between the Osceola and the Rhode Island, is developing the Kearsarge lode at the Tecumseh shaft. It is reported that good copper ground is being opened, though the lode here is considerably narrower than in the mines to the north. This shaft is down about 1,400 feet. Caldwell shafts Nos. 1 and 2 on the Kearsarge lode were each sunk below 500 feet in 1908. The ground here is considerably disturbed, and the showing of copper is not encouraging. The shafts will be sunk to prove the lode at depth.

The Rhode Island Company, whose property is north of the Franklin Junior, continued development in the Pewabic lode, principally on the ninth and tenth levels. Some good ground was proven, and plans were made to continue sinking, with the hope that the lode will improve in depth.

The Hancock mine, located southwest of the Quincy, confined its developments for the year largely to the West Branch lode and the West lode. No. 1 shaft was sunk 242 feet to the fourteenth level. Drifting during the year amounted to 2,463 feet. No. 2 shaft, which is a 5-compartment vertical shaft, was sunk 904 feet, to a depth of 1,435 feet. This is to be made the main working shaft of the mine and will be connected with No. 1 by crosscut, thus avoiding enlarging and equipping No. 1 for hoisting rock. It is estimated by the management that 400,000 tons of rock is blocked out in the mine.

At the Superior, northeast of the Baltic, No. 1 shaft was sunk to the tenth level, and drifting was begun in this level late in the year. This shaft shows improvement with depth. On the strength of the improved showing in No. 1 shaft, work was resumed at No. 2 shaft during the year. Shipments of rock coming from the development drifts were made to the Atlantic mill early in 1909. The Baltic lode shows unusual width in this property, and the mineralization is said to be improving with depth.

The Atlantic Company confined its developments for the year to section 16. The shaft was sunk to a depth of 1,786 feet, or 14 feet below the twentieth level. Crosscutting and drifting on the levels between the tenth and the twentieth levels developed some good stoping ground, but the rock is badly broken and the lode could not be followed continuously for any considerable distance. It is hoped by the management that on lower levels they will encounter the lode in its normal condition. Rock stamped during the year amounted to 270 tons and produced 12,230 pounds of mineral. The mill stamped 191,968 tons of rock during the year, most of it from the Michigan mine.

At the Globe the vertical shaft has cut the Baltic lode at a depth of 1,000 feet. Drifting on the tenth level has disclosed some good copper ground, but thus far it has proved bunchy. Further development will be necessary to prove the lode.

At the Challenge exploration was continued through the year, but no paying copper ground was developed.

The Elm River is sinking a shaft about 1 mile northeast of the former workings. It is planned to crosscut to the east from this

shaft in search of the Lake lode. A little copper rock has been encountered in this shaft.

During the year the Wyandot sunk shaft No. 11 to a depth of 700 feet and crosscut to the east, encountering an amygdaloid rich in epidote; apparently it is 24 feet wide, carrying a strongly mineralized shoot in the foot wall. About 100 feet of drifting in this bed gave encouraging results.

At the Winona operations were confined to development, no rock being shipped. Shaft No. 3 was sunk to a depth of 1,272 feet and No. 4 to a depth of 852 feet. Drifting to the amount of 5,001 feet and crosscuts to the amount of 597 feet developed rock of about average grade. The management estimate that 1,400,000 tons of milling rock are opened up and in sight in the mine. Early in 1909 plans were being made for the construction, in conjunction with the King Philip mine, of a stamp mill on Sleeping River.

The King Philip continued development during the year, sinking shaft No. 1 to 971 feet and No. 2 to 519.5 feet. Drifting and crosscutting to the extent of 2,923 feet were accomplished during the year. From shaft No. 1 the lode has been cut from the fifth to the tenth levels, and a cross cut was in progress on the eleventh level at the close of the year. Drifting on the sixth, eighth, and ninth levels disclosed rock of favorable character, particularly on the sixth and ninth levels. At shaft No. 2 the lode was cut on the sixth level, and early in 1909 rock carrying some shot copper was encountered. As already mentioned, this company, in conjunction with the Winona, is considering the erection of a 2-stamp mill on Sleeping River.

KEWEENAW COUNTY.

In 1908 Keweenaw County produced 19,806,216 pounds of copper and 595 fine ounces of silver, being 8.8 per cent of the copper and 0.2 per cent of the silver produced in the lake district. The county occupies the northern part of the Keweenaw peninsula and contains the northern portion of the copper belt. This section of the belt produced considerable copper in the early days of lake mining, but of late years has furnished a comparatively small percentage of the total output. Developments, however, indicate that the county should increase in importance in the future.

The following table shows the production of "rock" and "mineral" and the average yield in silver and copper in Keweenaw County for 1907 and 1908:

Production of "rock" and "mineral" and average yield in silver and copper in Keweenaw County in 1907 and 1908.

Year.	Silver.	Copper.			Mineral.		"Rock."
	Quantity.	Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fineounces.	*Pounds.*	*Pounds.*	*P. ct.*	*Pounds.*	*P. ct.*	*Tons.*
1907	497	18,595,931	15.8	0.79	25,163,445	73.9	1,176,247
1908	595	19,806,216	16.3	.81	26,209,977	75.5	1,213,071

From this table it is seen that for 1908 the county shows a slight increase in rock and a little higher recovery per ton of rock treated. The copper is derived entirely from amygdaloid, with an average recovery for 1908 of 16.3 pounds per ton, or 0.81 per cent.

Allouez.—The Allouez mine is north of the North Kearsarge, and, as in recent years, has confined its operations to the Kearsarge lode. As this lode does not outcrop on Allouez property, the shafts were started in the hanging wall at a steep angle and flattened to the dip of the copper-bearing bed just before reaching it. This plan avoids the expense of long crosscuts necessitated by vertical shafts. No. 1 shaft is below the twelfth level, at a depth of 2,598 feet, and on January 30, 1909, No. 2 shaft cut the lode at a depth of 2,304 feet. At this point there is said to be a very good showing of copper. During the year there was accomplished a total of 1,468 feet of shaft sinking, 3,775.5 feet of drifting, and 636 feet of crosscutting.

Rock amounting to 220,905 tons was treated at the mill, and yielded 4,716,105 pounds of "mineral" and 3,047,051 pounds of copper. The yield per ton of rock stamped, 13.79 pounds per ton, was slightly better than that for 1907, which was 13.66.

Ahmeek.—The Ahmeek, lying northeast and east of the Allouez, is also located on the Kearsarge lode. The lode is opened by 2 inclined shafts, No. 1 being down about 1,200 feet at the ninth level and No. 2, 1,334 feet at the tenth level. The lode has been extensively opened, and production can be materially increased when conditions make this desirable. The Kearsarge lode in this mine furnishes some of the richest amygdaloid rock in the district. During 1908 there were 298,178 tons of rock milled—184,939 tons at the Osceola mill and 113,239 tons at the Tamarack mill.

Mohawk.—The Mohawk, lying east of the Ahmeek, carries the outcrop of the "Kearsarge" amygdaloid for upward of 1 mile, and also contains several cross fissures carrying arsenides, which have been mined to considerable extent in the past. The Kearsarge lode is opened by 5 shafts: Nos. 1 and 2 have reached the seventeenth level; Nos. 3 and 4 the thirteenth level; and No. 5 the eighth level. It is planned to begin a shaft during 1909 that will command the ground between No. 5 shaft and the southern boundary of the property.

About 11,927 feet of drifting during the year opened up considerable copper ground. At No. 1 shaft openings on the lower levels showed no change in the productiveness. Some fair bunches of copper ground were opened in the lean ground north on the tenth, eleventh, and twelfth levels. The ground opened in No. 2 shows no improvement in the copper content, though there is a favorable change in the character of the lode. Good stoping ground was opened in No. 3. The openings on the lower level of No. 4 show more improvement. At No. 5 shaft the best ground encountered during the year was opened. This looks encouraging for the southern portion of the property.

During the year 685,823 tons of rock were stamped and yielded 10,295,881 pounds of copper, or 15.01 pounds per ton, a slight decrease from 1907, which averaged 15.77.

Arnold.—The Arnold continued exploration on the "Arnold" ash bed, and some mass copper was taken out and smelted at Portage Lake.

Exploration and development.—The Keweenaw Company confined its mining developments to the Medora lode on the Mandan-Medora tract. No. 1 shaft, driven at an angle of 23°, is down about 1,160 feet, with 13 levels and upward of 2 miles of workings. No. 2 shaft was started about the middle of the year. During the latter part of the year test shipments were made to the Phoenix mill, but they were discontinued early in 1909. Further development of the property is in progress.

At the Cliff mine of the Tamarack Company exploration was continued, 1,913 feet of drifting being done during the year. South Cliff was cleaned out below the fifth level, and exploratory drifts extended east and west from the fissure into the various amygdaloid floors. In some drifts copper values were disclosed, and a few carloads of rock were sent to the mill. Some of the rock proved to be poor; some gave fair results.

Late in the year unwatering of the Avery shaft near the Greenstone Bluff was begun. This is for the purpose of further exploration of the ninth and thirteenth floors of the old mine. Old reports state that the mine was well mineralized at these points.

The Ojibway, situated between the Cliff and the Seneca, continued the sinking of its 2 shafts on the Kearsarge lode. No. 1 was down about 600 feet at the close of the year. A crosscut to the west on the 500-foot level penetrated an amygdaloid bed about 30 feet thick, which showed considerable mineralization. No. 2 shaft is about 500 feet deep. Crosscuts from this shaft at the 350-foot and the 500-foot levels have cut an amygdaloid bed about 15 feet thick that shows paying values. Drill cores obtained from the lodes during 1907 are said to have indicated good values.

In July, 1908, No. 1 shaft was started on the Kearsarge lode in the Seneca, about 3,000 feet north of No. 1 shaft of the Gratiot. The shaft is sunk in the foot wall, and, at the end of the year, had reached a depth of about 175 feet. Drill cores from this lode are said to be promising.

The Gratiot, controlled by the Calumet and Hecla Company, has two shafts on the Kearsarge lode; No. 1, down 620 feet, and No. 2, 720. These are said to have a fair showing of copper,

ONTONAGON COUNTY.

In 1908 Ontonagon County produced 6,148,046 pounds of copper and 2,768 fine ounces of silver, or 2.7 per cent of the copper and 1.1 per cent of the silver produced in the Lake district. Five mines of the county made a production in 1908. Ontonagon County contains the southwestern portion of the copper belt. This portion has not been so thoroughly developed, and consequently the geology is less understood than in the more northern counties. So far as developed the lodes are more bunchy than to the north, and have produced a relatively high percentage of mass copper. The production for 1908 was derived wholly from amygdaloid lodes.

The following table shows the production of the county for 1907 and 1908:

Production of "rock" and "mineral" and average yield in silver and copper in Ontonagon County in 1907 and 1908.

Year.	Silver.	Copper.			Mineral.		"Rock."
	Quantity.	Quantity.	Yield per ton of "rock."		Quantity.	Yield.	
	Fine ozs.	*Pounds.*	*Pounds.*	*Per ct.*	*Pounds.*	*Per cent.*	*Tons.*
1907	1,971	7,216,690	12.1	0.60	10,794,960	66.8	594,986
1908	2,768	6,148,046	12.8	.64	8,267,668	74.3	480,186

From this table it is seen that the county showed a decrease in the production of copper and a marked increase in the output of silver. The copper recovered per ton of rock treated increased slightly. Developments during the last two years point to an increase in production for the county, though some of the mines can hardly expect to produce at a profit at the present price of copper.

Adventure.—On account of the low price of copper the Adventure mine ceased production at the end of January, and the mill remained idle for the remainder of the year. Development on the Knowlton lode was continued until about the middle of the year, 1,289 feet of drifting and crosscutting being accomplished. This opened ground that is about the average of the mine. Diamond drilling was carried on with encouraging results, which indicate that the property is crossed by two and possibly three copper-bearing lodes not located heretofore. At the close of the year drilling was still in progress to determine the location of a shaft for the exploration of these new lodes.

Mass.—The Mass mine, adjoining the Adventure on the southwest, carries 6 copper-bearing amygdaloid lodes—the Knowlton, the Mass, the North Butler, the Butler, the Ogima, and the Evergreen. Shafts A and B on the Evergreen have reached a depth of 1,757 and 1,857 feet, respectively. Crosscuts from these reach the Knowlton, the Butler, and the North Butler lodes. Shaft C, with a depth of 1,000 feet, opens the Ogima lode.

The production was considerably restricted during the year because of the low price of copper. Rock amounting to 171,268 tons was stamped at the 2-stamp mill on Keweenaw Bay, and yielded 2,607,750 pounds of mineral and 1,766,930 pounds of refined copper, an average of 10.31 pounds of copper per ton of rock stamped. This was a slight improvement over the rock treated during 1907.

Diamond drilling for the year is stated to have brought encouraging results.

Michigan.—The Michigan mine has 3 shafts on the Calico lode, with crosscuts reaching to the Branch lode and to other lodes of less importance. At present the production is largely from the Calico and the Branch lodes, though other lodes have contributed in the past. The mine has been a famous producer of "mass" copper, and the Branch lode is still the richest "mass" lode of the district, and, though narrow, one of the richest lodes mined.

The Calico lode is from 5 to 25 feet wide in the upper workings, but narrows at the 2,000-foot level to 4 to 6 feet. In the upper workings,

the copper occurs as a pay streak on the foot wall, with patches of good ground on the hanging wall and in the center of the bed.

The 3 shafts have the following depths: A, 2,111 feet; B, 1,781 feet; and C, 1,650 feet. The mine has about 10 miles of opening.

Developments in the upper levels from shaft A were not encouraging, but drifting on the fifteenth and sixteenth levels developed good copper ground. At B shaft drifting on the fourteenth and eighth levels was not very encouraging. The Branch vein showed a marked decrease in richness in "mass" copper for 1908. This was partly compensated for by the production of stamp rock from this lode. Considerable copper ground has been developed at the C shaft during the year, though the results of the work at this shaft are not as favorable as was hoped for at the beginning of the year.

During the year the company stamped 190,331 tons of rock yielding 3,270,250 pounds of mineral. In addition, 1,226,845 pounds of "mass" copper was produced, making a total of 4,497,095 pounds of "mineral" and "mass," yielding 3,000,206 pounds of refined copper.

Diamond drilling on the southern portion of the property disclosed two copper-bearing beds of some promise. Further drilling was in progress at the close of the year.

Victoria.—The Victoria is the most southwesterly of the Lake mines that have made important production. The first attempts at copper mining in the district are said to have been made at this locality, though its recent period of productiveness began in 1906. The present production is from the Forest lode. The old No. 2 shaft through which present operations are carried on is bottomed at the twenty-second level; explorations for the year were largely on this level. A crosscut was extended to the vein, and 755 feet of drifting on it disclosed 50 feet of pay rock and other small areas of copper rock. The exploration shaft was sunk to a depth of 121.5 feet; and 102.5 feet of drifting did not disclose values that warranted a continuation of the work. Crosscutting on the nineteenth level to the extent of 770 feet and a continuation of the tunnel started in 1907 for 206.5 feet did not develop any ground of sufficient richness for stoping. During the latter part of the year a diamond-drill section was completed from the north of the north crosscut to the northern boundary. Two beds were cut carrying some fine copper. Further drilling was in progress at the close of the year.

Production was somewhat curtailed and the cost was increased for a part of the year on account of the unusual shortage of water for the hydraulic plant. During the year, 109,015 tons of rock were stamped, which yielded an average of 11.8 pounds of copper per ton at a total cost of 12.366 cents per pound.

Exploration and development.—The Lake mine made no production in 1908, confining its efforts to the development of the Lake lode. The high values encountered where the lode was opened are reported to have continued in the developments of the year. The lode is unusually wide, showing 60 feet at the outcrop, and, so far as developed, it is said to be one of the richest amygdaloid lodes in the Lake district. Diamond drilling in search of the new Adventure lode on Lake ground had not met with success at the close of the year.

The North Lake Mining Company, formed in August, 1908, began the development of a tract north and east of the Lake mine. This property is thought to carry the extension of the Lake lode and of several others. Diamond drilling was begun late in the year to explore the property thoroughly. The overburden is heavy at this point, making exploration slow, and at the close of the year no copper-bearing lodes had been discovered.

MISSOURI.

By C. E. Siebenthal.

PRODUCTION.

The production of lead and zinc in Missouri in 1908 is shown in the following table:

Production of lead and zinc in Missouri in 1908, by districts, in short tons.[a]

District.	Ore.							
	Lead concentrates.				Zinc concentrates.			
	Galena.		Carbonate.		Sphalerite.		Silicate and carbonate.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Southwest Missouri:								
Alba-Neck City	122	$6,333	.....	.....	12,513	$444,188	3	$37
Ash Grove-Everton	124	6,614	45	$1,705	.....	.....	140	2,800
Aurora-Stotts City	182	10,136	2	60	6,485	220,557	3,168	60,439
Carl Junction	55	3,001	.....	.....	1,400	52,437	.....	.....
Carthage	14	621	.....	.....	3,840	130,297	6	98
Cave Springs	29	1,723	.....	.....	1,942	66,909	.....	.....
Duenweg-Porto Rico	5,030	119,721	61	1,654	16,413	596,795	1,760	36,947
Granby	474	25,375	81	1,454	4,325	151,668	8,622	197,598
Joplin	6,833	353,798	153	4,893	51,359	1,773,359	1,462	27,132
Oronogo	466	23,411	.....	.....	9,391	329,292	.....	.....
Sarcoxie-Reeds	1	50	.....	.....	2,616	104,484	275	5,700
Sherwood	46	2,496	.....	.....	644	20,210	.....	.....
Spring City-Beef Branch	1,172	68,274	161	4,968	968	33,367	3,510	64,652
Springfield	216	11,755	.....	.....	1,890	76,888	.....	.....
Spurgeon	606	31,023	161	3,486	1,993	61,560	959	20,144
Webb City-Prosperity	19,726	1,057,435	.....	.....	80,333	2,657,508	.....	.....
Wentworth	.....	19	.....	.....	317	10,606	327	6,624
Zincite	22	1,138	.....	.....	1,869	69,184	.....	.....
Total	35,118	1,722,923	664	18,220	198,298	6,799,309	20,232	422,171
Central and southeast Missouri	183,095	6,906,116	.....	.....	42	1,050	1,369	29,436
State total	218,213	8,629,039	664	18,220	198,340	6,800,359	21,601	451,607
Total, 1907	193,528	10,535,890	357	11,764	222,347	9,208,465	18,733	427,146

[a] The production of a single mine at Stotts City has been included with the production of Aurora to avoid disclosing individual production. In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York.

Production of lead and zinc in Missouri in 1908, by districts, in short tons—Continued.

District.	Metal content.			
	Lead.		Zinc.	
	Quantity.	Value.	Quantity.	Value.
Southwest Missouri:				
Alba-Neck City	96	$8,064	6,299	$592,106
Ash Grove-Everton	128	10,752	47	4,418
Aurora-Stotts City	146	12,264	4,349	408,806
Carl Junction	42	3,528	723	67,962
Carthage	11	924	1,950	183,300
Cave Springs	23	1,932	995	93,530
Duenweg-Porto Rico	4,114	345,576	8,973	843,462
Granby	436	36,624	5,407	508,258
Joplin	5,491	461,244	26,106	2,453,964
Oronogo	363	30,492	4,790	450,260
Sarcoxie-Reeds	1	84	1,474	138,556
Sherwood	36	3,024	321	30,174
Spring City-Beef Branch	1,024	86,016	1,686	158,484
Springfield	175	14,700	1,026	96,444
Spurgeon	584	49,056	1,277	120,038
Webb City-Prosperity	15,240	1,280,160	40,242	3,782,748
Wentworth	.....	.....	273	25,662
Zincite	18	1,512	951	89,394
Total	27,928	2,345,952	106,889	10,047,566
Central and southeast Missouri	116,531	9,788,604	515	48,410
State total	144,459	12,134,556	107,404	10,095,976
Total, 1907	138,675	14,699,550	116,752	13,776,736

The production of silver, the quantity of lead concentrates from which produced, and the crude ore from which the concentrates were derived, as well as the silver content of each in ounces per short ton, are given in the following table:

Production of silver in Missouri in 1907 and 1908.

Year.	Silver.		Lead concentrates, silver-bearing.		Crude lead ore, silver-bearing.	
	Quantity.	Value.	Quantity.	Ounces of silver per ton.	Quantity.	Ounces of silver per ton.
	Fine ounces.		*Short tons.*		*Short tons.*	
1907	[a] 25,692	$16,957	.....	.....	.....	.....
1908	[a] 49,131	26,039	26,488	1.855	441,190	0.111

[a] The quantities given in the first column of this table are those of recovered silver, not of assay content as given elsewhere in the mines reports. The silver content of the ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied upon for the silver production.

But one company produced copper in Missouri in 1907 and 1908. The copper production is therefore excluded from the tables of production.

The main lead and zinc producing regions of Missouri are in the southwestern and in the southeastern parts of the State. The former is the greatest zinc-producing area in the United States. The latter contains the districts of the disseminated lead ores, and in 1908 exceeded in production the Cœur d'Alene region, which in

recent years has held first rank in the United States. The central Missouri district has produced considerable ore in the past, but it is operated sporadically, and in 1907 and 1908 had so small a production that its output is included with that of southeastern Missouri. The silver and copper production of the State is limited to the southeastern district.

Much of the ore mined in the Western States is crude smelting ore; that is, it can be smelted directly without preliminaryconcentration. All but a very small portion of the ore from the Central States is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of tonnage of crude ore, or, as it is called in the Central States, "dirt." However, in those States it is only the larger companies which make any record of the crude ore raised. In the Joplin region the number of cans of ore hoisted is usually kept and the approximate weight of the cans is generally known. Thus each company knows, in a general way, about what percentage of concentrates the mine run is yielding. Knowing the total production of concentrates and the average yield of concentrates from crude ores, it is easy to arrive at an estimate of the crude ore raised in Missouri in 1908. Returns from all of the larger producers in southeast Missouri show that the average yield of lead concentrates from crude ore in 1908 was 6.66 per cent, from which the crude ore raised in that region may be calculated as 2,770,360 short tons. Taking the concentrate production of the Oronogo-Duenweg belt as that of sheet ground, and figuring the yield at 3 per cent of the crude ore, we get 4,439,333 short tons as the quantity of crude ore raised; figuring the yield of the disseminated ore of southwest Missouri at 4 per cent, we get 3,028,300 tons as the crude ore for that section, a total of 7,467,633 tons of crude ore raised in southwest Missouri, and a grand total for the State of 10,237,993 short tons. If the yield of concentrates from the disseminated ore of southwest Missouri be reckoned at 5 per cent instead of 4 per cent, it gives 2,422,640 tons of crude ore, making a state total of 9,632,333 tons. The corresponding state totals for 1907 were 10,507,508 tons and 9,799,773 tons. Iron ore being excluded, the greatest tonnage of ore raised by any other State is that of crude copper ore raised by Michigan, which amounted to 9,892,214 tons in 1907 and to 10,531,271 tons in 1908. On this basis Missouri probably ranked first in 1907 and second in 1908 in crude-ore production in the United States.

SOUTHWEST MISSOURI.

The southwest Missouri lead and zinc area includes the largest part of the Joplin region, the remaining portion lying in southeastern Kansas and in northeastern Oklahoma. The ore occurs in the Boone formation and in rocks of Kinderhook age, both belonging to lower Carboniferous. The ore deposits are found in Jasper, Newton, Lawrence, Greene, and adjoining counties. In 1908 this area produced 87 per cent of the lead ore and 85 per cent of the zinc ore raised in the Joplin region.

The lead ores are galena, with a small quantity of lead carbonate, locally known as "dry bone;" the zinc ores are sphalerite, or zinc

blende, or "jack;" zinc carbonate (smithsonite), and zinc silicate (calamine), both of the latter locally called "silicate." The galena contains but a small fraction of an ounce of silver to the ton of lead concentrates, and although ordinarily it is not desilverized, yet occasionally the refineries find it advantageous to add lead from the Joplin region to their charges, without, however, making any record of the silver content. In this way an unknown but small quantity of silver is recovered from southwestern Missouri lead ore. The zinc ores, sphalerite, smithsonite, and calamine contain notable quantities of cadmium, being fully as rich in this respect as the zinc ores of Silesia, which are the source of the cadmium production of Europe. The discussion of the cadmium content of these ores is taken up more fully in the chapter of Mineral Resources for 1908 entitled "Cadmium."

The ore deposits of the Joplin district vary in character with the depth of mining. The shallower ores beginning at the surface are universally pockety, and are found in residual clays or in "runs" in the basal breccias of the region. The breccias and the forms of the "runs" are largely, if not altogether, due to solution of the limestone strata. One form of run which is fairly numerous is the "circle" deposit, which in the popular view has come to be nearly synonymous with rich deposits. Small veins, vertical sheets, thin crevice deposits are often met with in prospecting, but unless they develop into stringers leading into paying ore bodies are forgotten in the multitude of rich pockety deposits which the district has yielded. The blanket deposits or "sheet ground" are found in the Grand Falls chert member of the Boone formation at depths varying from 125 to 300 feet, depending on the topography and the geologic structure. Below this horizon there are, in the rocks of Kinderhook age, deposits of disseminated ore. They have been struck in prospect shafts or drill holes near Springfield, Aurora, Granby, Carterville, Joplin, Hornet, and Cave Springs, in Missouri; at Galena, in Kansas; and at Quapaw, in Oklahoma.

The beginning of 1908 found the zinc-mining industry in the Joplin region at a very low ebb, and this situation continued well on through the year. The adverse conditions fell heavily on the sheet-ground mines in particular. Through readjustment of the wage scale and partial recovery in the price of lead concentrates late in the year a number of sheet-ground mines containing a considerable proportion of lead with the zinc were enabled to resume operations, and the year closed with considerable promise.

ORE PRODUCTION.

Mining and milling practice in the Joplin region is so well known through the numerous articles that have appeared in the mining press of the country that but few words are necessary here. The type of mill erected in the district is carefully chosen to fit the needs of the particular kind of ore body to be exploited, and, being based on the evolutionary experience of nearly forty years, is in general wisely selected.

In early days of zinc mining in the district when only the richest runs and pockets of the "disseminated" deposits could be profitably worked, and the life of the individual mine was necessarily short, a

very simple type of concentrating plant came into use. It was equipped with a rougher jig and a cleaner jig, and had a capacity of 80 to 100 tons of crude ore per 10-hour shift. When a deposit was worked out, the mill could be easily and cheaply moved to another deposit. When the increased price of concentrates made it possible to mine lower grade ore, and the life of the deposits was thereby lengthened, somewhat larger and more complete milling plants came into vogue. Sand jigs and concentrating tables were added to the equipment, and the capacity was raised to 200 or more tons per shift. Such mills, developed by the necessities of local conditions, came to be characterized throughout the lead and zinc regions of the Central States as the "Joplin type."

A further increase in the price of concentrates, and the development of large bodies of low-grade "sheet-ground" deposits, insuring permanence and stability of operation and necessitating every refinement of concentration, has resulted in the modern "sheet-ground mill" with capacity from 350 to 1,000 tons of crude ore per 10-hour shift, driven by steam, natural gas, or electricity, with complete equipment of ore-saving devices and with attendant economies of power, operation, and concentration.

ORE SELLING.

As was noted in the introduction to this chapter, the lead and zinc ores of the Central States when marketed locally are sold on a plan which differs somewhat from the methods in vogue in the Western and other states where more complicated ores prevail. The producer is paid by the ton of concentrates, all ores being sold in that form. The price is arranged on a sliding scale, the foundation of which is the price paid for ores of a certain standard, namely, the "basis." In each of the ores a "basis" is arbitrarily taken which represents as nearly as may be the average metallic content of clean concentrate. In sphalerite or zinc blende concentrate the basis is 60 per cent (theoretical composition, 67 per cent) of metallic zinc, by wet assay or analysis; in the oxidized zinc ores, the carbonate and the silicate, the basis is 40 per cent (theoretical, 52 and 54 per cent) metallic zinc; and in galena concentrates the basis is 80 per cent (theoretical, 87 per cent) metallic lead. The buyer will offer so much for 60 per cent zinc ore which becomes the "base price." If the assay shows the concentrates to vary from the basis, $1 is added to the base price for each per cent of zinc above 60 and $1 subtracted for each per cent less than 60. Deduction is made for moisture, all concentrates being sold on dry, or net, weight. Penalties are exacted for the presence of undesirable elements, as iron, bitumen, barite, fluorspar, etc. One dollar is deducted for each per cent of iron above 1 per cent. The first ore sold from the new Miami district was penalized 2 "per cent," that is, $2 was arbitrarily deducted for the bitumen clinging to the concentrates. Fluorspar occurs in the zinc concentrates of western Kentucky and southern Illinois, but neither fluorite nor barite are found in quantity in the ores in the Joplin or the Upper Mississippi Valley districts. The practice of buying zinc blende concentrates on an assay basis became general in 1899, though it began in a small way a few years earlier.

Formerly the ore was bought on "flat bid;" that is to say, the buyer made a visual inspection and mental estimate of the metallic contents and then offered so much per ton for the particular concentrates in question. An expert buyer can estimate the metallic contents very closely. Galena concentrates are generally bought on flat bid, though buying on assay is increasing. Ore which is sold in lump, such as hand-picked galena, lead carbonate, and carbonate and silicate of zinc, is very generally sold on flat bid.

ASSAYS.

Several of the assayers in the Joplin district make a practice of saving the remnants of samples analyzed through the year. At the close of the year the lot is thoroughly mixed and carefully sampled, from which sample an average or composite assay for the year is made. Two representative series of such composite assays are given below. In most cases each sample included in the composite assay represents a carload lot of concentrates.

The first series, by W. W. Petraeus, of Joplin, gives the result of analyses of composite samples from the general district for the last twelve years. The analyses for 1897–1905, inclusive, were published in the Lead and Zinc News, volume 9, January 15, 1906, page 8. The analyses for 1906, 1907, and 1908 were kindly communicated by Mr. Petraeus. Iron was not taken into account until 1900. Some 400 scattering assays, made in 1895–96, are excluded from the table.

Composite assays of zinc blende from the Joplin region, 1897–1908.

[W. W. Petraeus, analyst.]

Year.	Composite sample.	Percentage of zinc.	Percentage of iron.
	Lots.		
1897	600	56.64	.....
1898	1,299	56.99	.....
1899	3,715	56.67	.....
1900	3,500	57.36	0.22
1901	3,683	57.53	2.02
1902	5,776	57.08	2.24
1903	6,014	57.30	2.00
1904	6,220	57.24	2.10
1905	4,628	57.97	1.84
1906	5,644	57.2	2.00
1907	6,813	56.8	1.93
1908	7,837	56.4	1.76

The composite sample for 1905 also assayed: Lead, 1 per cent; copper, 0.001 per cent; cadmium, 0.198 per cent.

The next series of composite assays was communicated by Prof. W. George Waring, of Webb City. The original samples were of ores from the different camps of the district except where otherwise indicated. The methods used in making these assays have been published.[a]

[a] Waring, W. George. The volumetric determination of zinc, Jour. Am. Chem. Soc., vol. 26, No. 1, January, 1904. In addition to the composite assays for 1902 and 1903 shown in the above table, the article gives the lead, copper, and cadmium content of a number of ores from individual mines in Missouri, Kentucky, and Illinois.

Composite assays of zinc blende from the Joplin region, 1900–1908.

[W. George Waring, analyst.]

Year.	Composite sample.	Zinc.	Iron.	Lead.	Cadmium.	Copper.
	Lots.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1900	3,894	57.30	3.03			
1901	5,172	56.00	3.30			
1901	2,757	55.30	3.86			
1901	[a] ±2,000	55.90	3.47			
1902	2,270	57.08	2.65	0.904	0.337	0.050
1903	2,145	57.75	2.32	1.072	.388	.049
1904	[a] 3,800	58.26	2.23	.701	.304	.049
1904	[b] 2,691	58.46	1.97	.720	.430	.050
1904	1,984	58.95	2.10			
1905	4,520	58.95	2.00			
1906	4,638	58.40	2.20			
1906	3,968	58.20	2.29			
1907–8	±4,000	58.70	2.00			

[a] Joplin. [b] Webb City.

The complete analysis of the composite sample of the 3,800 lots of concentrate from the Joplin district in 1904, sampled by C. V. Millar and analyzed by Waring, is as follows:

Analysis of composite sample of zinc blende from the Joplin region.

[W. George Waring, analyst.]

Zinc	58.26	Calcium carbonate	1.88
Cadmium	0.304	Magnesium carbonate	0.85
Lead	0.70	Barium sulphate	.82
Iron	2.23	Silica	3.95
Manganese	0.01		
Copper	0.049		99.773
Sulphur	30.72		

Both series of composite assays show a slight but gradual increase in the zinc content of the concentrates from the beginning of the series to the present time. The second series indicates a similar decrease in the quantity of iron. Both these changes are doubtless to be attributed to the increased efficiency of mills and milling practice, particularly in the sheet-ground districts. The first series shows indications of a lowering of the grade of concentrates by the custom-mill product of the gougers and scrappers in the latter part of 1907 and in 1908.

PRICES.

The two charts following show graphically for the years 1907 and 1908 the average price of spelter at St. Louis, the weekly average basis price of 60 per cent zinc concentrates at Joplin, and the weekly production of zinc blende in short tons by the Joplin region as a whole. The price of spelter has been taken from market reports, and the price of zinc blende and the figures of weekly production are those published in the Joplin Globe and the Joplin News-Herald.

The sharp weekly fluctuations in production result from the holding back one week for better prices and the heavy selling when prices are higher. The curve, strictly speaking, is that of sales, but throughout this report only that ore which has been marketed is considered in the production. To eliminate these weekly fluctuations and to

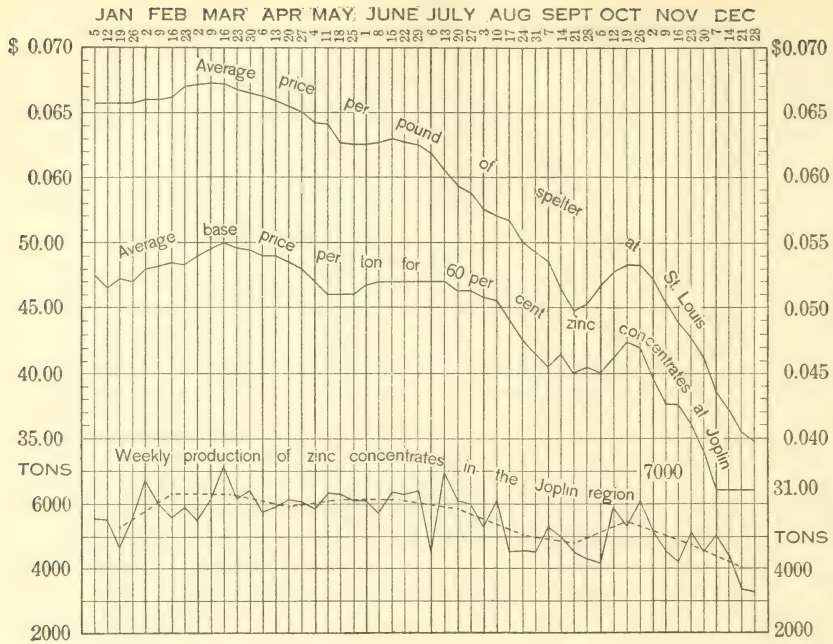

FIGURE 2.—Average weekly prices of spelter and of 60 per cent zinc concentrates, and weekly production of zinc concentrates in the Joplin region in 1907.

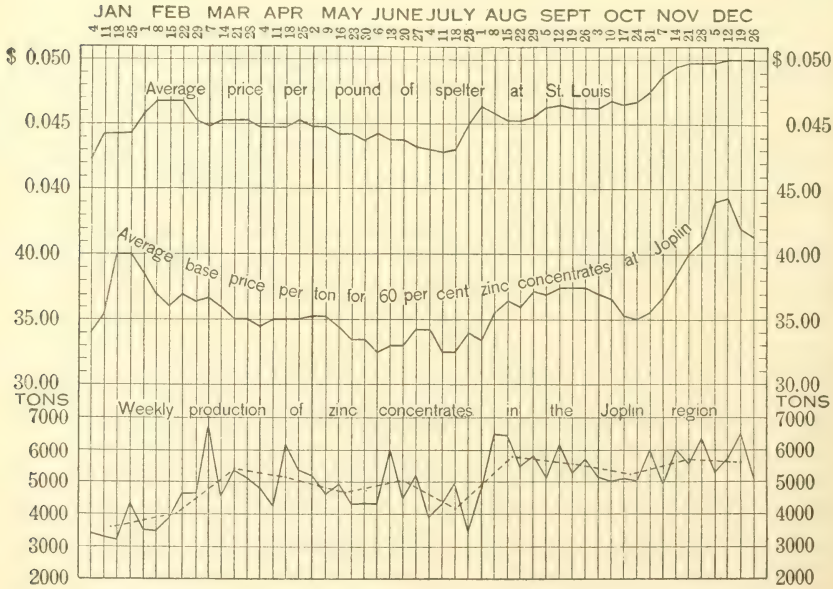

FIGURE 3.—Average weekly prices of spelter and of 60 per cent zinc concentrates, and weekly production of zinc concentrates in the Joplin region in 1908.

obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken line.

In the main the price of zinc blende closely follows that of spelter, the margin between them being naturally smaller as the price of each falls. Some discrepancies appear here and there, in part the result of scarcity of ore owing to inclement weather, breakage of natural-gas mains, holidays, etc., and in part the result of tariff agitation. Likewise the weekly production bears a close relation to the price fluctuations, especially as shown in the curve of weekly production averaged by months. This relation is somewhat counteracted, however, by the law of supply and demand, high prices resulting from a scarcity of ore, and vice versa.

REVIEW BY DISTRICTS.

Alba district.—The production of zinc blende in this district fell off nearly 50 per cent under the adverse industrial conditions. This was partly owing to the fact that the output of the mines is almost exclusively zinc ore, those mines yielding the higher-priced lead ore being better able to withstand the situation.

The Reliance Mining Company No. 3 made the largest production, the output of five mills, with a total daily capacity of 900 tons, including a sludge mill. The Penn Zinc Company and the Red Fox Mining Company both report a fine output. The East Alba Mining Company's land was in operation for only a portion of the year and the production was correspondingly reduced. For the same reason the Luke and Brown No. 3 Mining Company reported a much smaller output than in 1907. The H. B. H. lease, on the contrary, made a substantial gain in production over the preceding year. The O. K. Mining Company, the Rochester Land and Leasing Company, and the Eclipse Land and Mining Company were also among the producers. The Big Indian Mining Company ceased operations in April and abandoned the lease. On the Bowen lease of the Federated Mining and Milling Company, a cave-in carried down the milling plant of the Isabel Mining Company.

Ash Grove-Everton district.—The mining in this vicinity is all shallow, and the ores are mainly galena, lead carbonate, and zinc carbonate and silicate. In the vicinity of Ash Grove work was carried on by several partnerships, and a small quantity of lead and silicate ore was produced. At Everton, the Everton Mining Company raised a small quantity of silicate ore, and the Dade County Mining Company prospected for deeper ore. Some lead carbonate and zinc carbonate was produced by land belonging to the Underwriters Land Company near Corry, a few miles north of Everton.

Aurora district.—Coleman Brothers reported the largest production of the district. The output consisted wholly of high-grade zinc blende, and was mined at a depth of about 260 feet. Other companies reporting a good production of zinc blende were the Cleveland and Aurora Mineral Land Company, the Morgan & Pitts Mining Company, the Federal Lead and Zinc Company, and Scott, Coleman & Co. The Buckeye Milling Company produced zinc silicate and carbonate ore, and the Jones Land yielded zinc blende and silicate

ore. The United Zinc Companies did not operate the mill or the deeper ground, but subleased the shallower silicate diggings.

Other companies operating intermittently and making some production of blende or silicate, or both, were the Sphalerite Mining Company, the Myrtle J. Mining Company, George Stone & Co., the Morgan & Berry Mining Company, Ripper Brothers, C. C. Plank & Co., Jacob Thielan, the Black Land Mining Company, and the Boston-Aurora Zinc Company. Many mines in the Aurora district were either idle or operated in a desultory fashion with unimportant production.

Carl Junction district.—The Mohler-Smith Company is erecting a 150-ton mill which, when completed, will give the company a milling capacity of 350 tons. The tract operated is a portion of the old Lehigh diggings, which after a cave-in, was formerly worked as an open cut and is now reopened as such. A steam shovel has been installed to facilitate handling the ground. The product consists of zinc blende. The Hall and the Jubilee leases of the Avondale Land and Mining Company and the Robertson & Stuckey tract also were among the producers. The H. L. Kramer Mining Company erected a modern 400-ton concentrating mill on the Lochrie tract northwest of Carl Junction. The mill is equipped with 3 jigs, 4 Ford concentrating tables, and an automatic dumping cage for hoisting ore. The mill was not put in commission except for a test run.

Carthage district.—The Vesuvius Mining Company made a large production of zinc ore, concentrated on a single plant of 200-tons capacity. Douglas and Anderson, operating the Old Hayseed mine, and the Waddell Zinc Company reported production. The mines at Pleasant Valley and the Consolidated Troup mine, northwest of Carthage, were not in operation. At South Carthage, on the land of the Grier Mining Company, mining was limited to the operations of gougers and scrappers.

There was much activity in prospecting and development work in the Carthage district during the year. Following the drill strike on the Weaver tract, northeast of the Waddell mine, a shaft was sunk to the ore and a mill erected by the Tri-City Mining Company, which, however, was not put into operation in 1908. The Davy Crockett Mining Company developed an ore body on the Davey land, near the Vesuvius Mine, and erected a mill. A rich drill strike was reported from the old Porter tract, in the northwest part of Carthage, the scene of much mining about fifteen years ago. The Porter tract and the surrounding lots were leased and pumps were installed to unwater the old working. Near the close of the year the water was reported out and development work begun. The Magnet Mining Company prospected an 80-acre tract a mile east of Knight station, and a 100-ton mill was erected.

Cave Springs district.—The Herald Zinc and Lead Mining Company remodeled the 200-ton mill early in the year, installing Faust jigs and 3 concentrating tables. An incline shaft at a 45° angle was completed in September, with a length of 444 feet. Ore is reported in sheet formation in blue flint (Grand Falls chert member of Boone formation) between 180 and 220 feet in depth, and between 222 and 290 feet in shaly limestone. The lower run of ore is at the same horizon as that struck in deep drilling north of Galena, and is, in part at

least, in rocks of Kinderhook age. Mining is now being carried on at a depth of 290 feet; the product consists of zinc blende.

The Equitable Zinc and Lead Company and the Claycomb mine of the General Lead and Zinc Company were among the producers, the latter, however, only for a portion of the year. The William E. mine of the Federated Mining and Milling Company and the Consolidated Troup No. 4 mine were not put in operation. McCullough & Murdock installed pumps on the Hartley land, adjoining the Herald land, and in August the upper levels of the old workings were reported drained.

Duenweg-Porto Rico district.—In spite of the facts that most of the mining in this district is in the sheet ground and that the low ore prices for the year bore most heavily upon sheet-ground operators, the production of the district showed a gain upon that for 1907. The Ground & Irwin 80-acre tract made the largest production of the district, the output of five subleasing companies operating mills with 1,000 tons daily capacity. On the Chew land a large production of both lead and zinc was made from the Mercantile Metal and Milling Company's lease, and a small output was made by scrappers on the Federated Mining and Milling Company's lease on the same land. The Swayback Mining Company and the Criterion Mining Company, operating the American Zinc, Lead, and Smelting Company's land at Porto Rico, made a large production of zinc blende. Among other large producers of zinc ore were the Whitsett lease on the Trinity land and the Church-Mitchell Mining Company on the Acme land. The R. L. McGee Mining Company, operating the Home Talent Developing Company's lease of the Hall land, mined high-grade zinc-silicate ore. The ore occurs, in sheet form, from 55 to 105 feet in depth. The S. D. Mitchell land, producing zinc blende, operated for a portion of the year, as did also the adjoining Chase land. Other companies having a considerable output were the American Beauty No. 2, the Good Samaritan Mining Company, the Reliance Mining Company Nos. 1 and 2, and the Crown Crest Mining Company, the latter particularly of carbonate and silicate ores. Other companies operating for shorter or longer periods were the Boston-Duenweg Mining Company, Sayers Mining Company, Old Colony Zinc Company, Morgan, Simpson & Co., Log Cabin Mining Company, Sadtler Mining Company, and the Gussie K. Mining Company. The Greenhorn mill was destroyed by fire, as was also the large new Highland mill of the United Zinc Companies. The Coahuila Mining Company erected a new 300-ton mill on the Horton land.

Granby district.—The producing territory in the immediate vicinity of the town of Granby belongs to the Granby Mining and Smelting Company, which subleases mining lots and tracts to individual operators or companies. Most of the mining by individual operators is shallow and primitive in method and yields lead ore and zinc silicate ore, but the subleasing companies do deeper mining and have steam mills producing zinc blende. The depth of mining ranges from 40 to 150 feet. The aggregate capacity of the steam concentrating plants on the Granby tract is 1,000 tons daily. The largest mill is that of the Mascot Mining Company, rebuilt during the year, and with the capacity increased from 200 to 300 tons, followed by the new mill of the Granby Mining and Smelting Company of 250 tons capacity, and five other mills of about 100 tons each. A new

300-ton mill erected by Green & Roden, was destroyed by fire shortly after completion. The total tonnage of concentrates produced from the Granby tract was large, the relative quantity of zinc silicate, zinc blende, galena, and lead carbonate (dry bone) being in the order named.

The Mears Mining Company mines zinc blende on the Granby tract and on the adjoining Davis land. The ore on the Davis land is mined at a depth of 230 feet. The Pennsylvania Mining and Development Company also mined on the Davis land at a depth of 235 feet. The ore is reported to be in disseminated blanket form. Operating on the St. Paul Mining Company's land, Danke & Co. had a considerable output of zinc silicate. The Silver Plume mine on the Chase land is in new territory about 3 miles south of west of Granby. A new 300-ton mill was completed in April, and the production of zinc ore began before the close of the year. The ore is reported to occur in disseminated blanket form, lying between 250 and 300 feet in depth.

Joplin district.—The largest production of zinc ore and of lead ore in the district was turned in by the lessees of the Granby Mining and Smelting Company, one of the largest contributors to which was the Amalgamated Zinc and Lead Company. This company began the construction of a 250-ton mill, which was completed early in 1909. Discoveries of rich shallow lead ore in Leadville Hollow and elsewhere on this land were a feature of the year.

The Kohinoor tract of the Continental Zinc Company made its usual large production of zinc blende. On the Temagami sublease an inclined shaft was started. The Thousand Acre tract of the Rex Mining and Smelting Company made a large production of zinc blende and also of lead ore. Another large production of zinc blende is reported from the lands of the Connor estate in the vicinity of Joplin. Large production of zinc ore was also made by the John Jackson Investment Company, the Bullfrog Mining Company, the Schifferdecker land, the Chicago-Joplin Mining Company, the Lambert land, the Pittsburg-Missouri Lead and Zinc Company, the Leonard Realty Company, the W. E. Johnson land, and the United Zinc Companies. The Shoal Creek Mining Company reported production of silicate ore occurring in blanket formation at 65 to 110 feet. Another company reporting a good output of zinc blende is the Montgomery Lead and Zinc Company.

On account of the prevailing low price of zinc blende many companies which ordinarily have a large production limited operations to prospecting and development work and made but a moderate to fair output of ore. Among such may be mentioned Yale & Barbee, Rabbit Foot Zinc Mining Company, W. H. Taylor land, Roaring Springs Land and Mining Company, Marion B. Mining Company, Cameron Zinc Company, Luke & Ash land, Anderson Mining Company, Missouri Lead and Zinc Company, and the Adirondack Mining Company. A great many other companies practically suspended operations and made little if any production.

There was a considerable revival of mining operations in the vicinity of Midway. The Kalitan mill, erected in 1907, was overhauled and Faust jigs installed. A. W. Grannis erected a mill of 150 tons capacity. Both these companies, the Osyka Mining Com-

pany, and the Florence Lead and Zinc Company produced zinc ore, and the first named also considerable lead ore.

A revival was also brought about in the region southwest of Joplin by the discovery of a run of ore beneath the "bed rock," which was supposed to be the lower limit of ore in early operations in the vicinity of Tanyard and Gordon Hollows. Mattes Brothers having developed sheet ground by drilling on the John Jackson farm, and proved up the ore by several shafts, moved the 500-ton San Gabriel mill from the Porto Rico vicinity and re-erected it upon the tract.

Oronogo district.—In the Oronogo-Duenweg sheet-ground belt the mining is practically continuous throughout, so that the division lines of the districts are necessarily arbitrary. For convenience the Oronogo district is in this report considered to be limited to the region north of Center Creek.

The producing territory in this region is mostly owned by the Granby Mining and Smelting Company. Starting in the old circle deposits with shallow lead at the grass roots, the ore has been followed downward until the sheet-ground horizon has now been reached, at a depth of 240 feet. Some ore is yet produced at the higher levels, about one-thirtieth of the current yearly output having come from depths between 15 and 70 feet. The output for the year was large and was the product of the Oronogo Circle Mining Company, Aurora Circle Mining Company, Oronogo Mining and Development Company, and John W. Sweet. One new mill was erected and another rebuilt and enlarged, so that the concentrating capacity is now 1,200 tons daily. The Old Judge Mining Company completed a new 250-ton mill in April and produced zinc ore from sheet ground at a depth of 180 feet.

Sarcoxie-Reeds district.—The mines in this district lie between the two towns, and while the ore is largely shipped from Reeds the owners and operators generally live in Sarcoxie. A mine was developed on the J. N. Boyd land by the Cameron Mining Company, which began the erection of a 300-ton mill. On the Henry Boyd land a large production of high-grade zinc blende was made, the output of the Optimo Lead and Zinc Company, Copperhead Mining Company, Consolidated Mining Company, and Brewer Mining Company. The Lone Pilgrim Mining Company is reported to have made a strike and to be about to build a mill. The Goucher land yielded a good output of zinc blende. The Plymouth Rock mine on this tract was taken over by the Ravenswood Mining Company. On the Cale land the Greyhound Mining Company produced some high-grade silicate ore, cleaned on hand jigs.

Sherwood district.—The Creller and Young land was taken over by the Excelsior Lead and Zinc Company and yielded a production of zinc ore. The land of the Alamo Land and Mining Company was not mined during the year. Bailey & Stickney spent the year in development work and in the construction of a new 150-ton mill. The North Kimberley Mining Company, operating on the Mexico and Joplin land, reported a production of zinc blende from the 200-foot level. Sheet ground is reported from 268 to 288 feet in depth. The mine is equipped with a 200-ton mill.

Spring City-Beef Branch district.—Though less than a mile apart, the ore deposits of Beef Branch are very different from those of Spring City. The ores mined at the former camp are shallow lead and zinc

carbonate and silicate; those mined at Spring City are lead and zinc blende. Though the ore deposits of both camps have been worked for several years, it is since 1907 that the Spring City camp has had its greatest development.

The J. W. Allen land yielded a large production of zinc ore, mostly silicate, and considerable lead, the output of six subleasing companies, and all cleaned over hand jigs. A 75-ton mill is in process of construction. There was a large amount of prospecting on the tract and 25 shafts were being sunk at the close of the year. The Adam Scott lease made a large production of lead ore and considerable zinc ore. The lead ore was mainly raised by the Delta Mining Company. The Argosy mine and mill, on the same land, was taken over by the U. G. Wilson Lead and Zinc Company. The Alladin Mining Company, operating the St. Paul land, was also among the producers of lead and zinc ores.

The McKinney lease, on the Hoge land, made a large production of zinc silicate ore, the output of several sublessees operating with hand jigs. A good output of silicate ore was yielded also by the Owens land. Considerable production of silicate ore was made by the Zeta Land and Investment Company, and the Bales land and several other companies had small outputs.

Springfield district.—The Springfield mines are located on Pierson Creek, about 5 miles southeast of the city. The ore is reported to occur in channel or crevice deposits from 5 to 40 feet in width and 1,600 or 2,000 feet in length. The ore is galena and sphalerite, the concentrates of the former assaying 82 to 83 per cent metallic lead, and the zinc concentrates assaying 63 to 64 per cent metallic zinc.

The mine of the Daisy Mining and Milling Company, formerly operated by the Rathbun Mining Company, was worked in 1908 by W. Martin Jones, jr., producing zinc blende, together with considerable lead. The main shaft was sunk to a lower run of ore. The Badger Lead and Zinc Company reported a good production of lead and zinc ore, raised from a crevice deposit at a depth of 260 feet. Both the Daisy and the Badger mines are equipped with 100-ton mills.

Spurgeon district.—The output of the H. E. Bucklin land was somewhat reduced from that of 1907, and consisted for the most part of silicate ore. The 100-ton concentrating plant was destroyed by fire. The Bucklin & Wills tract maintained its production of zinc blende, with some silicate. There is a 50-ton mill on the ground. The Granby Mining and Smelting Company's land at this place produced zinc silicate ore and considerable lead. The Moseley mines, owned by the Duquesne Lead and Zinc Company, after having been shut down for a year, were pumped out in September and operated under lease by the Moseley Mining Company No. 2 until the close of the year. Prospecting was active on the old Baxter diggings, the output of lead and zinc silicate ores being cleaned on hand jigs.

Several mines southwest of Spurgeon, along or in the vicinity of the Seneca fault block, are included here for convenience. At the Buzzard diggings on the Newman land the construction of a 150-ton mill was begun, pending the completion of which mining was suspended. The Chandler Mining Company, operating 2 miles northeast of Racine, completed a 70-ton mill late in 1907, and produced some zinc blende in the early part of 1908. The De Masters Mining Company, on the Olson land, now the Aylor land, completed and began the operation of a 75-ton mill equipped with 2 concentrating tables. Considerable

prospecting was done on the site of the old Gallemore mines, 1 mile southwest of Racine, but no ore was raised. B. T. Becker, operating the old Potwin and Holmes mines, 1 mile south of Seneca, had some production, but spent the year chiefly in prospecting and development work.

Stotts City district.—The mines at Stotts City are situated on a north-south line along the valley of a small stream. The ore is practically all zinc blende, a little galena occurring in a single mine. Considerable pyrite occurs in some of the mines, and a carload was shipped in 1907. The majority of the mines are on the Stott land, held under first lease by the Mount Vernon Mining Company. One of the mines was in operation for a short time only. The Golden Jack Mining Company sank a new shaft and was otherwise employed in development work, making a small output of zinc ore.

Webb City-Carterville-Prosperity district.—This district includes the section of the Oronogo-Duenweg sheet-ground belt between Center Creek and Porto Rico, embracing the original and typical sheet-ground territory. As in other sheet-ground districts, the low ore prices had a depressing effect on the yearly production. In the case of the mines with a considerable percentage of lead ore the greater value and more rapid recovery in price of that ore enabled those mines to resume operations, while the mines yielding zinc ore alone were compelled to remain closed.

The Guinn land reported the largest production of the district of both lead and zinc ore. This was the output of a number of lessees, mining companies, tailings mills, and sludge mills, with an aggregate capacity of 3,300 tons per day. The Moark-Nemo Consolidated Mining Company began the construction of an 800-ton mill in 2 units on the dividing line of the Guinn and Aylor tracts. The ore from both tracts will be hoisted through one shaft but kept separate in milling. The mill will be equipped with Faust jigs and driven by gas engines.

The Underwriters' Land Company made a large production of ore operating the Golden Rod mill of 200 tons capacity and the Yellow Dog mill of 1,000 tons capacity per (10-hour) day. The latter mill, the largest in the Joplin region, is composed of 2 independent units, each connected with the mine by an inclined shaft, through which the ore is raised by a link-belt conveyor. The mill and hoisting apparatus are electrically driven.

The Rochester Land and Leasing Company reported a large production from the Hendrickson tract, the product of the Red Dog and Bull Dog mills and tailings and sludge plants. The Carter land, now owned by Charles A. Byrd, made a large output of ore, turned out by sublessees of the Glass Lead and Zinc Company and the Big Stick Mining Company. Four new mills were erected on the land in 1908, 2 by the Glass Lead and Zinc Company, 1 by the Bird Dog Mining Company, and 1 by the J. F. Robinson Mining Company. Other companies operating in the sheet ground north of Webb City and producing heavily were the Providence Mining and Milling Company on the Ashcroft land, American Beauty Mining Company No. 1, Golden Glow Mining Company, Kelley Land Company, Ware & Bowman land, and Vantage Lead and Zinc Company.

In the territory between Webb City and Carterville the Bradford-Kansas City Zinc Company, with its lessees, and the Center Creek Mining Company reported large ore production. On the latter land

new milling plants were erected by the Good Shepherd Mining Company, the Corrie Cole Mining Company, and the Central Mining Company. The Carterville Mining and Smelting Company, the Charter Oak Mining Company, and the Missouri Zinc Fields Company, in the same section, through their lessees, made good productions.

In the vicinity of Prosperity the American Zinc, Lead and Smelting Company operated half its concentrating capacity for half the year, yielding zinc and lead ore. The concentrating equipment of the company consists of three 750-ton mills, one 500-ton mill, and one 250-ton mill. The Rich Vale 300-ton mill was erected on the company land during the year. A steam shovel was installed underground to handle the crude ore, the work of which resulted in the order of an additional shovel, the latter driven by compressed air.

The Continental Zinc Company produced zinc and lead concentrates from the Litteral tract at Prosperity. A steam shovel was installed underground. The Daugherty land, operated by the Garnet Mining Company, made an output about equally divided between lead and zinc ore. The Aylor land and the Eleventh Hour tract made a large production of lead and zinc ores, the output of numerous lessees. The Connor land, south of Carterville, also had a large output of lead and zinc ore, made by the different lessees. Farther south the General Lead and Zinc Company, the Federated Mines and Milling Company, and the Gibson Mining Company all reported production of zinc ore, and the first mentioned reported also a large quantity of lead ore.

The forementioned mines comprise merely the most productive during 1908. There remains a long list of mines which pursued development or repair work and made less important outputs than the foregoing, and another list of mines which temporarily suspended operations.

Wentworth district.—On the Empire Zinc Company's land the Gobbler Mining Company operated the Gobbler mine and mill until July, after which the mill was worked on tailings by Bond & Co. The Cleveland and Sarcoxie Mining Company built a new 150-ton mill, which in August was transferred to A. F. Hartz. The ore produced by these companies was almost equally divided between blende and silicate. The depth of mining is about 80 feet. The Benua Mining Company did not put the Gamecock mine in operation during the year.

Zincite district.—The Belleville Land and Mining Company's tract made but a small output of ore, the subleasing companies remaining idle for the most part. The East Hollow Mining Company produced some zinc ore mainly by its lessee, the Colgan Mining Company. Among other producers were the Parkinson, Graves & Harper land, the Kantenwein Mining Company, the Tidioute Mining Company, and the Edgar County Prospecting and Mining Company. On the Brooks land O. and C. M. De Graff developed a mine and began the construction of a 200-ton mill.

CENTRAL AND SOUTHEAST MISSOURI.

The ore deposits of central and southeast Missouri reach in a more or less connected belt from the region of Morgan, Moniteau, Cole, and Miller counties on the northwest to the northern and eastern flanks of the St. Francis Mountains on the southeast.

The deposits in the northwestern portion of this belt, corresponding to the central Missouri region, are of the general type of those in the Joplin region, in that the ores consist of galena and sphalerite, or the oxidized derivations of those minerals, and occur in association with solution breccias and sink-hole shale patches, the ore being found in the Cambro-Ordovician dolomites and included cherts and occasionally in the shale. The occurrence of ore in crevices or thin vertical sheets is very common, but practically all the production of ore has been from sink-hole breccias or "circles," a form of deposit noted also as important in the southwest Missouri area.

The southeastern part of the belt, in the vicinity of the St. Francis Mountains, forms the disseminated lead region of southeast Missouri. The ore in this region is almost wholly lead, though a considerable deposit of zinc ore occurs at Valle Mines, some 6 miles north of the Bonne Terre district, and furthermore copper, nickel, and cobalt ores occur with the lead in the vicinity of Fredericktown in the southeastern portion of the region. The lead ore generally carries some silver, the average being less than 2 troy ounces to the ton of lead concentrates. The ore deposits are almost wholly in the lower part of the Bonne Terre limestone, where they occur in disseminated form over large areas, relatively richer in the vicinity of the intersecting crevices and joints. The crevices show little if any displacement, and there are no breccias of consequence. The copper, nickel, and cobalt ores occur with galena and marcasite in blanket formation in the carbonaceous beds of parting at the contact of the Bonne Terre limestone with the La Motte sandstone below, and in the vicinity of the intersection of this contact with the sloping surface of the pre-Cambrian rocks. Both the Bonne Terre and La Motte formations are of Upper Cambrian age, according to Ulrich.

The southeast Missouri deposits have been known and worked for about two hundred years. The earlier workings were shallow and even yet considerable shallow lead is raised, generally in connection with the mining of barytes, or "tiff," as it is locally known. The mines in the disseminated lead region range from 100 feet to about 550 feet in depth, depending on the depth from the surface to the basal portion of the Bonne Terre limestone. Prospecting is done by means of the diamond drill, and extensive campaigns of drilling have been prosecuted in the vicinity of all the important producing tracts. Just before the panic of 1907 there were nearly 100 diamond drills actively employed in prospecting.

The silver production of southeast Missouri was 25,692 fine ounces in 1907, and 49,131 ounces in 1908. The production for 1908 was recovered from 26,488 tons of lead concentrates representing less than 15 per cent of the total production of lead concentrates for the year. The remaining 85 per cent of the concentrates from southeast Missouri was not desilverized. The average silver content, calculated from the returns for 1908, was 1.855 ounces to the ton of concentrates and 0.111 ounce to the ton of crude lead ore.

The annual reports of the Missouri Bureau of Mines and Mine Inspection and the report of the Missouri Bureau of Geology and Mines upon the disseminated lead deposits of St. Francois and Washington counties have been freely consulted in the preparation of these notes.

REVIEW BY COUNTIES.

Moniteau County.—The Monarch Coal and Mineral Company is working a thick pocket of cannel coal near Barnett. Associated with this coal pocket there is considerable galena and zinc blende, chiefly in breccias adjacent to the coal and shale. The mine is equipped with a 50-ton mill and made some production in 1908. The mine and mill of the Missouri Lead Company, located 5 miles northeast of California, were not in operation during the year.

Phelps County.—A campaign of prospecting was carried on in the vicinity of Newburg by the Newburg Mining and Drilling Company. Numerous strikes are reported in prospect shafts and drill holes. The Newburg Lead and Zinc Company produced some lead ore on its 30-ton mill.

Crawford County.—The Missouri Copper Mountain Mining Company has mines near Sullivan. The concentrating mill has a capacity of 100-tons and is equipped with log washer, crushing machinery, 4 jigs, and a Wilfley table. There is also a 36-inch water-jacket blast furnace for reducing the copper ore. The ore is chalcopyrite with more or less of the products of oxidation, malachite, and chalcocite. There are shallow deposits of lead and zinc on the same tract, but not in association with the copper ore body. Deposits of specular hematite have been worked on this tract for many years and are yet yielding ore. These deposits change in depth into the sulphides of iron and are reported to show some chalcopyrite. The mines were not operated in 1908.

Washington County.—The Nina Realty Company, formerly the American Lead and Barytes Company, reported a good production of lead from the company land, mined at odd times by the barytes miners, generally from shallow depths and in association with barytes. It was all cleaned by hand. There are numerous other shallow lead and barytes diggings scattered over Washington County, which are worked by small operators who sell their product to the country merchants.

Jefferson County.—The Valle Mining Company owns a tract of mining land in Jefferson and St. Francois counties which is leased to individual small operators. The ore is cleaned entirely by hand. A good output of lead and zinc carbonate ore is reported for the year.

St. Francois County.—The St. Joseph Lead Company maintained the position held for a number of years as the greatest lead producer in southeast Missouri. The mines with one exception are situated at Bonne Terre and Leadwood. Shaft No. 8 is situated near Flat River station. These mines are all joined by spurs to the Mississippi River and Bonne Terre Railroad, 50 miles in length, which connects with the St. Louis, Iron Mountain and Southern Railway at Doe Run Junction and at Riverside, crosses the St. Louis and San Francisco Railway at Crystal, and the Illinois Southern Railway at Flat River. The smelter at Herculaneum, on Mississippi River near the north terminus of the railroad, is equipped with 2 modern furnaces and 5 Savelsburg roasting pots. The two concentrating plants, the Hoffman mill at Leadwood and the St. Joseph mill at Bonne Terre, have a combined daily (twenty-four hours) capacity of about 3,000 tons. The new producer-gas engine electric power plant at Bonne Terre was completed late in the year and furnishes power to the mill and adjacent mines.

The Doe Run Lead Company's mines are at Doe Run and near Flat River, except the Mitchell shaft, which is about 3 miles west of Flat River. The present concentrating capacity is 1,500 tons, but there is in course of erection near Elvins a new steel electric-driven mill of 1,800 tons capacity per twenty-four hours. A producer-gas engine power plant was completed at the mines in Flat River. The concentrates produced by the Doe Run Company are taken by the St. Joseph Lead Company and smelted at Herculaneum.

The Desloge Consolidated Lead Company's mines are in the vicinity of the town of Desloge except the No. 4 shaft, which is near Leadwood. There were 3 shafts in operation in 1908 and a fourth shaft was equipped for mining, hoisting, and crushing. Mining extends from a depth of 300 to 500 feet. The concentrating plant has a capacity of 1,000 tons per 24-hour day, and is equipped with a full complement of jigs and tables.

The St. Louis Smelting and Refining Company has its mines near Flat River. There are 5 shafts and the ore is mined at a depth of about 400 feet. The concentrating plant has a capacity of 1,600 tons per twenty-four hours, and is equipped with Hancock jigs, Overstrom tables, and Frue vanners. A central steam power plant drives air compressors and electric generators. The mill, hoists, and pumps are operated by electricity, as well as the underground haulage and the electric trams for handling the ore from the shafts to the mill.

The Federal Lead Company operates 7 mines through 5 shafts in the vicinity of Flat River, Central, and Elvins. The average depth of the workings is about 400 feet. The ore is milled over 2 plants, No. 1 having a capacity of 800 tons and No. 2 a capacity of 3,000 tons per twenty-four hours. The latter is a modern mill of best design, with full complement of Richards classifiers, Hancock jigs, Wilfley tables, and Frue vanners. Power for milling and mining is furnished from a central power plant of steam turbine-driven electrical generators. Electrical underground haulage is installed.

Madison County.—The North American Lead Company at Fredericktown completed its smelter about the middle of the year and began the regular production of electrolytic ingot copper, ingot nickel, and cobalt oxide. The present capacity of the smelter is 150,000 pounds of copper, 60,000 pounds of nickel, and 20,000 pounds of cobalt oxide per month. The lead is sold as it comes from the mill in the form of concentrates. The ore consists of an intimate mixture of the sulphides of copper, lead, nickel, cobalt, and iron in the form of chalcopyrite, galena, linnæite, and pyrite. The lead, as far as possible, is removed in concentration, the iron is removed by roasting and magnetic separation, and the resulting concentrate is smelted in the furnaces. The further separation of the copper, nickel, and cobalt is accomplished by electrochemical means.

The Madison Lead and Land Company, near Fredericktown, is operating the mine formerly known as the Catherine. There are 2 shafts, 130 and 160 feet in depth, respectively. The old mill of 200-ton capacity is located on the bank of Little St. Francois River and is connected with the mine by a long aerial tramway. A mill of 300 tons capacity, built at the mine in 1906, was enlarged to 500 tons capacity in December, 1908. The mills are equipped with Hancock jigs, Overstrom tables, and double-deck circular buddles 18 feet in diameter. The ore bodies are in the limestone and yield about 6 per

cent of lead concentrates, no copper or nickel-cobalt sulphides of consequence having as yet been found.

The Hudson Valley Lead Company was succeeded by the Eastern Lead Company. The mine is located near Mine La Motte station, about 3 miles from Fredericktown, on land leased from the Mine La Motte Lead and Smelting Company. It is operated both by shaft and by incline, ore being hoisted by the former and the men entering the ground by the latter. The mill is of Joplin type, has a capacity of 225 tons, and is equipped with jigs and Deister concentrating tables. The copper and nickel-cobalt sulphide ores occurring with the lead ore are stored, awaiting such time as the smelter at Fredericktown shall make a market for ore of this class.

The Mine La Motte Lead and Smelting Company is operating on deposits which were first located in 1720. The shallow deposits at first worked were followed down to a depth of about 100 feet, from which level the ore has been coming which for fifty years has supplied the mill and smelter. No. 4 shaft has now reached a depth of 170 feet. The old mill of 250 tons capacity is equipped with jigs and concentrating tables. A modern 500-ton mill was completed early in 1908. The smelter was not operated. Certain areas in the mines of this company yield copper and nickel-cobalt sulphide ores. These were formerly smelted by the company, but recently have been avoided, attention being limited to the lead ores.

The Wheeling Milling Company was succeeded by the Fort Henry Lead Company, which leased 100 acres of the Mine La Motte tract, added a crusher section to the mill, and began to mine at depths of 40 to 60 feet. The mill has 400 tons capacity and is equipped with Hartz, Cooley, and Hancock jigs and Standard concentrating tables.

OKLAHOMA.

By C. E. Siebenthal.

PRODUCTION.

The production of lead and zinc in Oklahoma in 1907 and 1908 is shown in the following table:

Production of lead and zinc in Oklahoma in 1907 and 1908, by districts, in short tons.[a]

District.	Ores.								Metal content.			
	Lead concentrates				Zinc concentrates.				Lead.		Zinc.	
	Galena.		Carbonate.		Sphalerite.		Carbonate and silicate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Miami	1,730	$92,177	.....	.....	6,475	$139,595	.....	.....	1,381	$116,004	2,690	$252,860
Peoria	2	80	.....	.....	24	617	261	$6,325	2	168	125	11,750
Quapaw	504	26,076	.....	.....	3,539	109,779	19	300	398	33,432	1,714	161,116
State total.	2,236	118,333	.....	.....	10,038	249,991	280	6,625	1,781	149,604	4,529	425,726
Total, 1907.	662	44,771	5	$275	3,076	119,008	650	15,667	532	56,392	1,657	195,526

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses in case of zinc, but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the metal is calculated from the average daily quotations at New York.

The workable deposits of lead and zinc in Oklahoma, so far as known, are confined to the northeastern portion of the State, within the limits of Ottawa County. They form the southwesternmost extension of the ore deposits of the Joplin region. They occur chiefly in chert breccias, but occasionally in limestone and sandstone breccias. The sandstones belong to the Chester group, the cherts to the Boone formation, and the limestones to either the one or the other, both being of lower Carboniferous age. The ores are galena, sphalerite, or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, never containing as much as an ounce of silver to the ton of lead concentrates.

REVIEW BY DISTRICTS.

Miami district.—Beginning with a single producer in the latter part of 1907, this district had, at the close of 1908, eight steady producers, each with creditable yearly outputs. In spite of low prices and poor recovery the Miami mines were able to operate with fair regularity on account of the richness of the ore. A standard-gage railroad, 4 miles in length, connecting the mines with the St. Louis and San Francisco Railroad at Miami, was completed just before the close of the year. Crude petroleum is used for fuel, being hauled to Miami in tank cars and pumped from there to the mines.

The ores are galena and sphalerite, in about the proportion of one of the former to three of the latter, no oxidized ores having yet been found. They occur at a depth of 90 to 130 feet in sandstone breccias and in flint breccias lying below the sandstone. The sandstone is impregnated with a heavy oil, which, evaporating to asphalt, causes much trouble to save the concentrates, in that it balls up the ores on the jig beds and tends to float off the finer particles of ore. It also has a tendency to lower the grade of the concentrates by enveloping them in films of carbonaceous matter and so causing finely powdered marcasite and pyrite to stick to them. As the scope of mining operations widens, however, there is a noticeable rise in the grade of the concentrates. The average zinc content of the zinc concentrates sold in 1908 was about 50 per cent, the latter half of the year and the first part of 1909 each showing improvement in this respect over the preceding period.

The New State Mining Company completed a small mill in 1907 and made several short test runs while adjusting the machinery to the character of the ore. Steady operations were begun about the middle of 1908. The Emma Gordon Mining Company, after an extensive drilling campaign on a 120-acre lease, sank 2 shafts and completed a 400-ton mill of modern sheet-ground type in the forepart of 1908, and made the largest production of the district. The Old Chief mine and mill, in course of construction early in the year, were leased by the Weiss Mining Company, which had a large output of zinc. The Buckeye mine and mill were operated by the Queen City-Joplin Mining Company. The Temple and Chapman Zinc and Lead Company operated the King Jack mine and produced lead and zinc ores in nearly equal quantities. The Turkey Fat Mining Company operated during the last three months of the year. The

Moosehead Mining Company, operating the Tom Lawson mine, after a run of several months, ceased operations, and the mill was moved away. The Kenwood Mining Company operated the Index mine. The year closed with several mills in process of erection.

Peoria district.—The principal production of this district consisted of high-grade zinc carbonate ore, and was made by Gordon & Wilkins, operating the Silicate mine during the first quarter of the year. W. W. Scott, operating the Cowan lease, also produced zinc carbonate ore. The Syndicate Mining Company made a small production of zinc blende. The shallow lead diggings in the vicinity yielded several small lots.

Quapaw district.—The mining companies of this district, for the most part operating blanket ground with small mills, found the prevailing low prices for ore a serious setback. Several of the heaviest producers of the preceding years practically suspended operations, but these were offset by the opening of several steady producers in the northern portion of the district, so that the total production for the year exceeded that for 1907.

The Eastman Lead and Investment Company early in the year remodeled the 200-ton Joplin-type mill at the White Eagle mine. Two additional concentration tables were put in, making 3 in all, and classifiers were installed. Three more tables will be added the coming year. The production of zinc ore was the largest recorded in the district for the year.

The Good Luck Mining Company has one of the new mines in the north end of the district. The ore, which is mostly zinc blende, occurs in broken or confused ground, in contradistinction to the majority of mines in this district. A 100-ton mill of the Joplin type was completed and started in October. Another new mine in the same vicinity is the Lancaster, which operated a 150-ton mill equipped with concentrating tables.

In the southern portion of the district the Mission mine yielded the greatest production of zinc concentrates and in addition turned out a good quantity of lead. The M., K. and T. mine was operated for a short time only. The Big Chief Mining Company developed a mine in the blanket ground southwest of the Mission mine, moved the Ayers-Sloan mill to it, and operated for a short time before the close of the year. The Kramer-Morse mine and mill was sold to the Hawkeye Mining Company, which operated for a portion of the year and obtained a corresponding output of zinc and lead concentrates. Among other principal producers were the Sweeney Mining Company, operating the McAllister mine, the Old Abe Mining Company, and the Mason Mining Company. The Chicago-Quapaw Lead and Zinc Company moved the Spring River mill to the Big Squaw mine just at the close of the year, and sunk a deep well to afford water for milling purposes.

WISCONSIN.

By C. E. Siebenthal.

PRODUCTION.

The production of lead and zinc in Wisconsin in 1907 and 1908 is shown in the following table:

Production of lead and zinc in 1907 and 1908, by districts, in short tons.[a]

District.	Ore.						Metal content.			
	Lead concentrates.		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Carbonate and silicate.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Benton	1,560	$83,783	11,430	$189,741	786	$5,292	1,236	$103,824	3,833	$360,302
Cuba City	1,426	78,802	6,258	163,227	5	67	1,123	94,332	2,740	257,560
Dodgeville	176	9,135	393	7,285	16	298	139	11,676	176	16,544
Hazel Green	601	30,260	9,016	132,266	.....	.....	479	40,236	2,597	244,118
Highland	332	15,719	1,706	46,151	2,143	27,467	257	21,588	1,340	125,960
Linden	328	16,188	2,422	72,371	50	500	251	21,084	1,040	97,760
Livingston	66	3,493	6,070	87,163	22	311	50	4,200	1,797	168,918
Mifflin	275	15,381	2,878	69,529	9	105	223	18,732	1,053	98,982
Mineral Point	194	9,547	2,126	42,115	175	2,539	155	13,020	866	81,404
Platteville	248	12,570	5,856	188,886	.....	.....	193	16,212	2,764	259,816
Potosi	40	2,456	.....	.....	.....	.....	32	2,688	.....	.....
State total	5,246	277,334	48,155	998,734	3,206	36,579	4,138	347,592	18,206	1,711,364
Total, 1907	4,408	266,471	47,251	997,127	3,065	40,422	3,499	370,894	18,490	2,181,720

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, and that the value of the metal is calculated from the average daily quotations at New York.

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties, and comprise the most important part of the ore deposits of the upper Mississippi Valley region. The ore deposits occur in the Galena limestone and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite or zinc blende, and smithsonite or zinc carbonate, the latter locally known as "dry bone." As a lead region the district has been known from the earliest settlement days. In time the building of smelters near by made a market for the zinc ores. The first zinc ore to be mined was the carbonate found in association with lead in the shallow workings above ground level. When all the main deposits were worked out down to water level, there was a lull in mining in the region. Though the carbonate was known to give place to zinc blende and the lead to continue on below water, it was not deemed profitable to mine when continued pumping was necessary. About eight or ten years ago the higher price of zinc led to the opening of some of the deposits below water level, since which time zinc mining has increased until Wisconsin for 1908 stands fourth in rank among zinc-producing States. The ore bodies are found in perpendicular, horizontal, or inclined cavities known as "openings" or "crevices,"

"flats," and "pitches." These openings sometimes extend for considerable distance in a straight line called a "range" and may be operated at different places by different companies. When a range is once established, it becomes an important guide in prospecting.

The galena of the district is nonargentiferous, and so far as known the zinc ores are free from cadmium. In some of the mines marcasite is so plentiful that the zinc blende concentrates are reduced to a very low grade. Owing to their nearness in specific gravity, marcasite and blende are very difficult to separate by hydraulic methods. Both electrostatic and electro-magnetic separation processes are in operation. Twenty-five concentrating plants in the district are equipped with roasters and magnetic separators, in addition to which the Joplin Separating Company, at Galena, makes a business of separating low-grade blende-marcasite ores, and the Mineral Point Zinc Company operates a roaster and magnetic separator at Mineral Point. The Benton Ore Separating Company was incorporated to build a custom roaster at that place. The concentrates, after being dried, are roasted, the customary form of roaster being a long, slowly revolving cylinder lined with firebrick. The roasting is carried far enough to render the marcasite magnetic, but not to drive off all the sulphur, after which the concentrates are passed under the magnetic separator and the iron is removed. The American Zinc Ore Separating Company finished an electrostatic separator at Platteville in the early part of 1908. It is equipped with driers and both Blake-Morscher and Huff electrostatic separating machines. In this system of separation the expense and attendant losses of roasting are obviated and the separated marcasite finds a market at about $4 per ton. Starting with a capacity of 75 tons daily, it has since been increased to 100 tons daily output. The multiplication of individual and custom roasters, by raising the low-grade ores to high grade, will have a tendency to reduce the tonnage of zinc concentrates, though, of course, the metal content and the value will not be affected; hence these must serve as the basis of comparison for different years.

Milling practice is much as in the Joplin region, except that everything is on a smaller scale in Wisconsin. Many of the mills are from 35 to 50 tons capacity and have but a single jig. Those of 100 tons or over, with rougher, cleaner, sand jigs, and concentrating tables, have generally been built in the last few years. There were about 50 new concentrating plants erected in 1907, many of them being of the larger size. During 1908, mill construction was naturally much less active, and there were but 15 mills completed during the year. The crude ore yields from 5 to 20 per cent or more of zinc concentrates. The contracts, in the case of the larger mills, generally call for a saving of 85 per cent of the blende in the crude ore, but very likely in practice this figure is not often attained. The mining methods are largely determined by the mode of occurrence of the ores, but otherwise are similar to those in vogue in working the pockety ores at Joplin. During the year the Interstate Light and Power Company absorbed several municipal electric lighting plants, secured franchises, and formulated plans to construct a large central power station to supply light and power all over the district.

The zinc carbonate ore is chiefly taken by the Mineral Point Zinc Company and made into zinc oxide in the plant at Mineral Point, Wis. A considerable quantity of the low-grade zinc blende concentrate is used in the same way. Only the higher-grade zinc blende concentrates are sold for manufacture into spelter.

REVIEW BY DISTRICTS.

Benton district.—The Bureau Mining Company, having had its concentrating plant destroyed by fire, purchased the Ida 50-ton mill, and rebuilt it at the Bureau mine late in the year. The Benton Mining and Development Company produced galena and blende from the Pittsburg-Benton mine and prospected the Drum lease south of Leadmine. The Corr raised lead ore and an equal tonnage of dry bone before the mill was burned in November. The Dawson mine and mill were sold and reorganized as the Reich Mining Company. The Etna Mining Company and the Frontier Mining Company each had a considerable production of zinc blende and some lead ore. The Fox Lead and Zinc Company acquired a roaster and magnetic separator, and produced zinc blende with a small quantity of lead ore. The Ollie-Belle mine of the Mifflin-Linden Mining Company was equipped early in the year with a 100-ton mill furnished with Wilfley tables, but the mill was not put in operation. The mill of the Pacific Gold Mining Company was burned and the mine subsequently abandoned. The Wilkinson Mining and Milling Company hand cleaned a good quantity of lead ore. The Aragon Lead and Zinc Company moved and rebuilt the Snowball mill at the Aragon mine.

There were several smaller producers and others engaged in development work.

Cuba City district.—The following are among the larger producers in this district: The Baxter Mining Company continued its output of zinc concentrates. The Best Mining Company added a roaster to its concentrating plant and marketed zinc ore and considerable lead. The Dall Lead and Zinc Company reported a large production of lead and zinc concentrates. The Vandeventer Lead and Zinc Mining Company completed a mill early in the year and marketed zinc concentrates. The Board of Trade Mining Company completed a 100-ton mill rather late in the year, and produced some high-grade zinc concentrates, together with some lead ore. The Henrietta Mining Company completed a 40-ton mill early in 1908 and joined the ranks of producers of lead ore. Several other companies added to the production of the year. The Pittsburg Lead and Zinc Company purchased the Cook mill and moved it to the Pittsburg Mine.

Dodgeville district.—The Blue Mounds Mining and Smelting Company and the McKinlay Zinc Mining Company marketed zinc ore, and the Swastika Mining Company, lead ore. Several other mines operated only for a short time.

Hazel Green district.—The Kennedy Mining Company completed a 100-ton, gasoline-driven mill late in the year, and have now two 100-ton mills operating upon ores from the same body, which, as developed at present, consists of pitches 1,000 feet in length. The company produces zinc concentrates and also considerable lead ore.

Another large production of zinc blende was reported by the United States Zinc Company, which succeeded the Mills Mining and Reduction Company in the operation of the Mills mine. A new roasting and magnetic separating plant was added during the year. The ore body is made up of flats and accompanying pitches at 208 feet in depth. In mining, the whole cross section, 85 feet in height and 520 feet in width, is taken up. Several companies report a small production in development work. The Scrabble Creek Mining Company, after an extensive campaign of drilling, is sinking upon an ore body.

Highland district.—The Highland Mining Company operated two mills, one, of 50 tons capacity, upon zinc carbonate ores, and a new 100-ton mill upon zinc blende ores. The Franklin Mining Company produced zinc carbonate ore together with some lead. The Wallace Mining Company mined zinc and lead ore, which was milled on the Milwaukee Mineral Company's mill. There were several smaller producers in the district.

Linden district.—Among the producers of zinc blende and lead ore in this district were the Dark Horse Mining Company and the Ross Brothers Mining Company. The Glanville Mining Company reported production of zinc blende. The Platteville-Linden and the Racine-Linden mines were in operation for short periods. The Mason mine of the Mifflin-Linden Mining Company was abandoned in March, and the mill moved to the company's property at Highland.

Livingston district.—Among the principal producers in this district were the Coker mine of the Mifflin-Linden Mining Company, the Sunrise Mining Company, the Senator Mining Company, and the Washburn Mining Company. The latter purchased the New Crescent mill and erected it late in the year. The Union Zinc Company took over the Sunset mine and mill. The D. D. & C. mine was sold to the Senator Mining Company and the mill in course of erection was enlarged to 100 tons capacity.

Mifflin district.—The Grunow Mining Company, the Peacock Mining Company, and the Slack Mining Company were among the larger producers of zinc blende in this district, and the Slack company marketed considerable lead ore as well. The Peni Mining Company equipped a 75-ton mill in August, and the Squirrel Mining Company, after prospecting and development work, began the erection of a 50-ton mill.

Mineral Point district.—The Merry Christmas Lead and Zinc Mining Company made an output of zinc ore, but closed down after a short period of operation. The Harris Mining Company, the Liverpool Mining Company, the John Ross Mining Company, and the Hoare Mining Company also reported production. The Hazel Patch Mining Company's plant was removed when the company failed in September. A new company will take over the mine in 1909.

Numerous suits for damages by the fumes of the acid plant of the Mineral Point Zinc Company caused the company to contemplate the removal of the works to the side of their smelter at Depue, Ill., but matters were compromised and the works will remain at Mineral Point.

Platteville district.—About the middle of the year the Wisconsin Zinc Company, affiliated with the American Zinc, Lead and Smelting

Company and the American Zinc Ore Separating Company, was organized and took over the Acme, Empire, Royal, and Mitchell Hollow mines. Later in the year the Royal plant was dismantled, the mill being moved to the Mitchell Hollow mine and the roaster being added to the one already equipping the Empire mine. The Empire and the Acme mines were in operation and reported production of zinc blende concentrates. The St. Rose Mining Company, the Weigel Mining Company, the Hodge Zinc Mining Company, the Homestead Mining Company, and the Klar-Piquette Mining Company were also among the producers. The Lyght Mining Company rebuilt the Rico mill at the Lyght mine; the Cruson Mining Company built a new mill and produced some zinc ore; and the Cleveland-Victory Lead and Zinc Company began the erection of a new mill at the close of the year.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES.

(MINE PRODUCTION.)

By H. D. McCaskey.

INTRODUCTION.

This report is a brief review of the gold, silver, copper, lead, and zinc mining industries of the Eastern or Appalachian States for 1908, and contains the statistics of their production of these metals for that year. The area covered is for the greater part coincident with the broad belt of old metamorphic and associated igneous rocks extending southwesterly from Vermont to Alabama. The zinc-lead belt of southwest Virginia, however, and its extension southwestward into eastern Tennessee lies to the west of this great belt and is contained within the limestone and dolomite of Cambro-Ordovician time.

In addition to the mines of gold, silver, copper, lead, and zinc ores, which form the main consideration of this report, pyrite mines known to be actually producing copper are taken into account, and the tonnage of chalcopyrite or cupriferous pyrite, given as closely as possible, is, for the purpose of this report, the tonnage of these mines.

The production set forth in the following tables is based on confidential individual reports by mine operators to the United States Geological Survey and may differ in details from that reported for the various metals by smelters, refiners, and the United States Mint. The latter represent the actual production in marketable form of metals treated during the year, and may represent in part ore mined during the previous year; whereas the mine figures aim to give the recoverable metals in the ore mined and sold or treated during the year in review. For a given series of years the figures should closely agree, and for any individual year the lag at the close of the year is usually small, being largely compensated for by a corresponding overlap at the beginning of that year.

The cooperation of mine operators and others of the mining industry with the United States Geological Survey has continued to be most cordial, and is here gratefully acknowledged.

PRODUCTION.

The total value of the production of gold, silver, copper, lead, and zinc in the Eastern States for the calendar year 1908 was $5,152,007. This represents the output of 105 producing mines, of which 58 were gold placers. The gold production was 12,536.04 fine ounces,

equivalent to $259,143, and the yield of silver was 66,170 fine ounces, valued at $35,070. Compared with the corresponding figures for 1907, these figures show an increase of $19,241 in the value of gold and a decrease of $21,466 in that of silver. The falling off in silver production noted for 1907 continued in 1908 and may be ascribed directly to the decreased mining of copper ore following the lower prices for that metal in 1907.

During 1908, 1,537.57 fine ounces of gold and 173 fine ounces of silver were obtained from placer workings, 10,627.10 fine ounces of gold and 1,668 fine ounces of silver were derived from quartz mines, and 364.63 fine ounces of gold and 64,210 fine ounces of silver were recovered from copper ores. Lead ores produced, in addition, 7.74 fine ounces of gold and 119 fine ounces of silver.

There were 43,446 short tons of dry or siliceous ores mined in 1908, with an average gold and silver value of $5.30 per ton; 624,449 short tons of copper ore, with an average precious-metal value of $0.06 to the ton; and 800 short tons of lead ores, with an average gold and silver value of $0.28 per ton. Omitting the 618,806 short tons of copper ores from Ducktown, Tenn., averaging only $0.05 per ton in gold and silver values, there remains the very small quantity of 5,643 short tons of copper ore mined elsewhere in the Eastern States in 1908, with the higher precious-metal value, however, of $1.42 per ton. During this year a total of 418,519 short tons of zinc ore producing no gold and silver were mined, chiefly in New Jersey, and of this quantity 95,812 short tons were used directly in the making of spelter, of which 47,453,540 pounds were produced. Some of the zinc ore mined was used in making zinc oxide, and for other purposes than smelting for spelter, and some of the spelter produced was from treating old tailings from Virginia mines.

In addition to the gold and silver, the copper ores produced 19,880,894 pounds of copper, valued at $2,624,278, and the lead ores, 76,190 pounds of lead, valued at $3,200, in 1908. There was also a production of copper and gold included above from the treatment of old tailings resulting from magnetic concentration of the iron ore of the Cornwall mines in Pennsylvania. The copper production showed a decrease of 426,286 pounds in quantity and of $1,347,158 in value, and the lead production a decrease of 64,409 pounds in quantity and of $4,251 in value, as compared with the corresponding figures for 1907; but the output of spelter increased 24,705,347 pounds in quantity and $865,643 in value over that of the preceding year.

Following is a tabulated statement of the production of the Eastern States for 1907 and 1908:

Mine production of gold, silver, and associated metals in Eastern States in 1907 and 1908.

	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Pounds.*	
1907	11,605.26	$239,902	85,661	$56,536	20,307,180	$4,061,436
1908	12,536.04	259,143	66,170	35,070	19,880,894	2,624,278
Increase (+) or decrease (−)	+930.78	+19,241	−19,491	−21,466	−426,286	−1,437,158

Mine production of gold, silver, and associated metals in Eastern States, etc.—Continued.

	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
1907	140,599	$7,451	22,748,193	$1,364,673	$5,729,998
1908	76,190	3,200	47,453,540	2,230,316	5,152,007
Increase (+) or decrease (−)	−64,409	−4,251	+24,705,347	+865,643	−577,991

The total tonnage reported from deep mines as producing the five metals in 1908 was 764,507 short tons, yielding a total value of $5,120,131 in gold, silver, copper, lead, and zinc. This gives an average total recovered value in metal of $6.71 per ton of ore for 1908. The corresponding average value for 1907 was $6.29.

GOLD.

The production of gold in the Eastern States in 1908 was 12,536.04 fine ounces, valued at $259,143 [a]—an increase in value for 1908 of $19,241 over that of 1907. The most notable increases were in North Carolina and Alabama, amounting to something over $15,000 in each case. All the remaining States producing gold, except New Hampshire, showed decreased outputs, the greatest decrease being $8,601 in Georgia, which showed the most important increase in 1907. The increased yield in Alabama was mainly due to the activity at the Hog Mountain mines, and that of North Carolina may be ascribed to general increased interest in gold mining throughout the mineral belts of the State. The decreased yields in Georgia, South Carolina, and Vermont were directly due to misfortunes at the principal producing mine in each State.

SILVER.

The production of silver in the Eastern States in 1908 was 66,170 fine ounces, valued at $35,070. [b] As compared with the corresponding production for 1907, a decrease of 19,491 fine ounces in quantity and of $21,466 in value is noted. This decrease in quantity was primarily due to the decreased production of copper ore, the chief source of silver in the Appalachian States, as shown by the greatly lessened output of these ores from North Carolina and Vermont, a loss not offset by an increased production from New Hampshire and Tennessee. The decrease in value of the silver production was even more marked, being governed not only by the decreased output of the metal but by its materially lessened value per fine ounce. It is notable also that less silver was recovered from the Ducktown ores, per pound of copper produced, in 1908 than in 1907. As shown below the total amount of silver recovered in the Eastern States from sources other than copper ores was very small.

[a] The value of gold is $20.671834625323 per fine ounce.
[b] The Survey figure for the average value of silver in 1908 is 53 cents per fine ounce. The figure for 1907 was 66 cents.

COPPER.

In 1908 the copper production of the Eastern States was 19,880,894 pounds, valued at $2,624,278.[a] The most important copper mines of these States are the well-known mines of Ducktown, Tenn., and these contributed about 98 per cent of the total product during 1908. Alabama produced no copper from pyrite ores mined in 1908; Vermont produced no copper, silver, or gold from the Orange County mines; Maryland and Massachusetts, none of these metals; Georgia produced no copper; and in North Carolina and Virginia the mining of copper ores was greatly curtailed. On the other hand the Milan copper mines of New Hampshire and the Cornwall magnetite mines of Pennsylvania yielded notable additions to the output, the latter from the concentration of tailings resulting from magnetic dressing of the iron ores.

In 1907 the copper production of the Eastern States was 20,307,180 pounds, valued at $4,061,436, at the average price of 20 cents per pound for that year. The decrease of production for 1908 was therefore 426,286 pounds in quantity and $1,437,158 in value.

LEAD.

The production of lead in the Eastern States, never in recent years of great importance, dropped from 140,599 pounds, valued at $7,451, in 1907, to 76,190 pounds, valued at $3,200, in 1908.[b] The output was confined to a single mine in Virginia, the mines of New Hampshire and Georgia reporting no production of lead in 1908. The total quantity of remaining workable lead ore is probably small in the Appalachian States, and there does not seem to be ground, from present information, for the expectation of important future supplies of lead from this region. The total quantity of lead ore produced by the mines in 1908 was 800 tons, averaging 4.8 per cent of metal, and carrying gold and silver valued at $0.28 per ton.

ZINC.

The production of metallic zinc or spelter in the Eastern States in 1908 was 47,453,540 pounds, valued at $2,230,316.[c] This was an increase over the production of 1907 of 24,705,347 pounds in quantity and of $865,643 in value. In addition to an output of 95,812 short tons of zinc ore producing spelter mined in 1908, 322,707 short tons of ore were produced and used for the manufacture of zinc oxide and for other purposes, and a considerable tonnage of old tailings (considered as crude ore in the tables) from ores mined in previous years was re-treated in 1908. The zinc ores of the Appalachians produce no gold nor silver. The average production of spelter per short ton of crude ore treated was 535 pounds. This ore would average, therefore, 26.75 per cent of recoverable zinc. Old tailings were not considered in arriving at these figures, although in the tables they were classed with crude ore, and lowered the average content to 495.3 pounds of recovered spelter per short ton of ore and tailings treated.

[a] The Survey figure for the average value of copper in the United States in 1908 is 13.2 cents per pound.
[b] The Survey average price for lead in 1907 was 5.3 cents, and for 1908 was 4.2 cents, per pound.
[c] The Survey average price for spelter in 1908 was 4.7 cents per pound. The corresponding price for 1907 was 5.9 cents per pound.

Mine production of gold and silver in Eastern States in 1908, by States, in fine ounces.

State.	Gold.		Silver.		Increase (+) or decrease (—) in value compared with 1907.	
	Quantity.	Value.	Quantity.	Value.	Gold.	Silver.
Alabama	1,993.44	$41,208	282	$149	+$15,226	— $141
Georgia	2,719.01	56,207	200	106	— 8,601	— 464
Massachusetts, New Hampshire, and Pennsylvania	211.30	4,368	6,270	3,323	+ 4,368	+ 3,208
North Carolina	4,716.32	97,495	1,260	668	+ 15,302	—13,632
South Carolina	2,598.46	53,715	226	120	— 1,050	+ 38
Tennessee	178.94	3,699	57,696	30,579	— 126	— 7,937
Virginia	118.57	2,451	236	125	— 5,878	— 2,538
Total	12,536.04	259,143	66,170	35,070	.....	.....
Increase (+) or decrease (—) compared with 1907	+930.78	+19,241	—19,491	—21,466	+ 19,241	—21,466

Source of gold and silver in Eastern States in 1908, by States, in fine ounces.

State.	Gold.				Silver.			
	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.
Alabama	45.72	1,947.72	.....	.....	4	278	.....	.....
Georgia	541.85	2,177.16	.....	.....	42	158	.....	.....
Massachusetts, New Hampshire, and Pennsylvania	.....	.....	211.30	.....	.....	.....	6,270	.....
North Carolina	849.23	3,867.09	.....	.....	114	1,146	.....	.....
South Carolina	39.18	2,556.28	3.00	.....	10	65	151	.....
Tennessee	29.61	.....	149.33	.....	.....	.....	57,696	.....
Virginia	31.98	78.85	.....	7.74	3	21	93	119
Total	1,537.57	10,627.10	363.63	7.74	173	1,668	64,210	119

Number of producing mines, ore production, and average value of gold and silver per ton in Eastern States in 1908, by States, in short tons.

State.	Number of mines.			Ore production from deep mines and average recovered value in gold and silver per short ton mined.								
					Dry or siliceous ores.		Copper ores.		Lead ores.		Zinc ores.	
	Placer.	Deep.	Total.	Total production.	Quantity.	Average value.	Quantity.	Average value.	Quantity.	Average value.	Quantity.	Average value.
Alabama	3	2	5	11,174	11,174	$3.616	.....	.....	.....	.....	.....	.....
Georgia	22	12	34	6,196	6,196	7.293	.....	.....	.....	.....	.....	.....
Massachusetts and New Hampshire	....	2	2	3,710	.....	.....	3,710	$1.88	.....	.....	.....	.....
New Jersey	....	1	1	66,634	.....	.....	.....	.....	.....	.....	66,634	.....
North Carolina	26	16	42	9,088	9,070	8.881	18	.....	.....	.....	.....	.....
South Carolina	2	5	7	16,795	16,776	3.152	19	7.526	.....	.....	.....	.....
Tennessee	2	4	6	638,033	.....	.....	618,806	.05	.....	.....	19,227	.....
Virginia	4	4	8	12,877	230	7.135	1,896	.....	800	$0.279	9,951	.....
Total	59	46	105	764,507	43,446	5.30	624,449	.064	800	.279	95,812	.....

Mine production of copper, lead, and zinc in Eastern States in 1908, by States, in pounds.

State.	Copper.		Lead.		Zinc (spelter).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Massachusetts, New Hampshire, and Pennsylvania	375,625	$49,583				
New Jersey					45,354,430	$2,131,658
North Carolina	19,393	2,560				
South Carolina	1,600	211				
Tennessee	19,459,501	2,568,654			688,149	32,343
Virginia	24,775	3,270	76,190	$3,200	1,410,961	66,315
Total	19,880,894	2,624,278	76,190	3,200	47,453,540	2,230,316
Increase (+) or decrease (−) compared with 1907	+426,286	−1,437,158	−64,409	−4,251	+24,705,347	+865,643

Number of copper, lead, and zinc producing mines, ore tonnage, and average pounds of metal recovered per short ton of ore in Eastern States in 1908, by States.

State.	Number of mines.			Copper ore.		Lead ore.		Zinc ore.	
	Copper.	Lead.	Zinc.	Quantity.	Average per ton of ore.	Quantity.	Average per ton of ore.	Quantity.	Average per ton of ore.
Massachusetts and New Hampshire	2	....	....	3,710	50.9				
New Jersey	....	....	1					66,634	680.6
North Carolina and South Carolina	2	....	....	37	160.8				
Tennessee and Virginia	3	1	3	620,702	31.4 12.4	800	95.2	29,178	35.8 141.8
Total	7	1	4	624,449	31.5	800	95.2	95,812	495.3

THE MINING INDUSTRY BY STATES.

ALABAMA.

The production of gold and silver in Alabama for 1908 was 1,993.44 fine ounces of gold, valued at $41,208, and 282 fine ounces of silver, valued at $149. This shows an increase over the production of 1907 of 736.56 fine ounces of gold, valued at $15,226, and a decrease of 157 fine ounces of silver, the net increase being valued at $15,085. There were no copper ores nor cupriferous pyrite ores mined in Alabama in 1908, although small quantities of cement copper were recovered from the treatment of pyrite ores mined in 1907 at Pyriton, in Clay County.

The Appalachian gold belt crosses the Georgia-Alabama line and terminates in east-central Alabama in a triangular area including parts or all of Cleburne, Randolph, Clay, Talladega, Tallapoosa, Coosa, Chilton, and Elmore counties. The geologic relations of the gold belt have been briefly described by Phillips,[a] Brewer and Smith,[b] McCaskey,[c] and others, who have studied them in the field.

[a] Phillips, W. B., A preliminary report on a part of the lower gold belt of Alabama: Bull. Geol. Survey Alabama No. 3, 1892.

[b] Brewer, W. M., Smith, E. A., Hawes, G. W., Clements, J. M., and Brooks, A. H., A preliminary report on the upper gold belt of Alabama, with supplementary notes on the most important varieties of metamorphic or crystalline rocks of Alabama: Bull. Geol. Survey Alabama No. 5, 1896.

[c] McCaskey, H. D., Notes on some gold deposits of Alabama: Bull. U. S. Geol. Survey No. 340, 1908.

The rocks of this area include the Ocoee group (consisting of metamorphic rocks, chiefly slates and sandstones), of Cambrian age; a smaller area of later slates, probably Devonian or early Carboniferous, lying along the northwestern border of Clay County; gneisses and schists, probably pre-Cambrian; and intrusive granites and greenstones. Three fairly well defined belts of "Talladega" slate, provisionally correlated with the Ocoee, strike northeast through this area and dip rather steeply to the southeast. Within these belts and along their borders with the granites and gneisses occur most of the gold and pyrite deposits. The Hog Mountain fissure veins, however, are in granite, and some of the lenticular veins are in gneiss.

During 1908 the Hog Mountain mines of the Hillabee Mining Company were worked, and exhaustive metallurgical experiments, with the view to ascertaining the most satisfactory process for treatment of the ores, were continued; and development and experimentation with the ores of Gold Ridge were also carried on. The pyrite mines of Pyriton were closed throughout the year, and there was but little placer working at Chulafinnee, Arbacoochee, or Clear Creek.

From Clay County the Southern Sulphur Ore Company, operating the pyrite mines at Pyriton, reported no production for 1908. The ores from these mines are sold to sulphuric-acid and fertilizer plants, and there has been some production, as by-products, of copper, silver, and gold from them in the past. From ores mined in 1907 there was copper recovered, some of which was reported by the smelters for 1908. The shaft is 350 feet deep. The ore from the mines is treated in jigs and shipped as concentrates. In Cleburne County there was a small production of placer gold from Arbacoochee and Clear Creek. The dredge built to operate on this stream has not been active for several years, and the sluicing experiments made in 1906 and 1907 have been productive of but little gold. In Randolph County the Gold Ridge Mining Company carried on development work at Gold Ridge, in the northeastern part of the county, near the Georgia line, and produced a small quantity of gold from the operation of their 20-stamp amalgamation mill. There is a 60-foot vertical and a 110-foot incline shaft, and there are about 250 feet of drifts and crosscuts. Development work at the mine began in May, 1908, and the erection of the mill was begun in September, being nearly completed by the end of the year. Toward the end of the year the cyanide process was decided upon for saving that portion of the gold lost in amalgamation, and a plant according to the Imlay rapid cyanide process has been contracted for. The ores are gold-bearing siliceous and oxidized pyrite ores, partly free milling above water level, and will probably become sulphides in depth. In Tallapoosa County the Hog Mountain mines of the Hillabee Mining Company, near Yates, furnished the greater part of the gold production of the State, as they have done for several years past. The general geological relations and the ore deposits were briefly described in a Survey paper published in 1908.[a] The vertical shaft was 118 feet deep, and crosscuts amounted to 300 feet, in 1908. The ore is treated in a 75-ton dry crushing mill and cyanide plant, for which a 200-horsepower water-power plant has recently been installed. The gold ores are partly in the oxidized zone, but mainly below, and the management has been conducting a long series of very thorough tests of methods for

[a] McCaskey, H. D., Notes on some gold deposits of Alabama: Bull. U. S. Geol. Survey No. 340, 1908, pp. 39–41.

securing the best practicable extraction of gold from them. A recent interesting paper[a] by T. H. Aldrich, jr., president and general manager of the Hillabee Gold Mining Company, is the source from which the following notes are taken:

The "red" ore of the oxidized zone is approximately one-third free milling and two-thirds combined in some unknown way. Stamp milling experiments have all failed, as illustrated by a trial run of 10 tons of $12 ore in which the plates caught $1.50, the concentrates contained $2.50, the tailings $4, and the slimes $4. Chlorination also failed to produce the desired results. A variation of the cyanide process, consisting of dry crushing to pass the ore through ⅛-inch by ½-inch slots and alternate leaching and draining, finally gave a 90 per cent extraction in a shorter time and with a lower consumption of cyanide solution than by the usual process. This treatment of the "red" or surface ore, which averages about $4 to the ton in gold, has been efficient and economical in practice. The main ore supply of the mines, however, is the "blue" ore, found below the oxidized zone. This contains gold locked up in a combination insoluble in cyanide solutions and not yet fully understood, in a tough, bluish-white quartz gangue. The general average value of the ore is about $4 to the ton in gold. Treatment of this ore by the cyanide process used for the "red" ore yielded an extraction of but 50 per cent of the gold; and grinding to 200 mesh and agitation yielded but 75 per cent, with a considerable loss of cyanide from the reducing agents in the ore. Next was tried the experiment of heating in a revolving kiln to 300° F., after dry crushing to ⅛-inch by ½-inch screen and before leaching by cyanide solution. The effect of this heating was the microscopic disruption of the ore, probably from expansion and bursting of included gases and water in the quartz, and increased porosity was obtained. The treatment was cheap, but the extraction still remained at only 75 per cent of the gold in the ore. Fine grinding again, with agitation in hot cyanide solution carrying 5 pounds of magnesia per ton, gave a 90 per cent extraction but unsatisfactory precipitation of the gold in the zinc boxes. Cyanidation of the "blue" ores will probably finally give way to a new process from which good results have so far been obtained in trial runs. The treatment is a complex amalgamation process by which the ore is ground in a 5-foot by 22-foot tube mill together with copper sulphate, salt, iron, and mercury. The mercury is readily floured in this operation, but is cleansed after leaving the tube mill and before passing finally over plates. The extraction expected is over 90 per cent, and the process is said to be considerably cheaper in operation than any cyanide treatment yet tried.

GEORGIA.

Mine production of gold and silver in Georgia in 1907 and 1908, in fine ounces.

Year.	Gold.		Silver.		Total.
	Quantity.	Value.	Quantity.	Value.	
1907	3,135.09	$64,808	864	$570	$65,378
1908	2,719.01	56,207	200	106	56,313
Increase (+) or decrease (−)	−416.08	−8,601	−664	−464	−9,065

[a] Aldrich, T. H., jr., The treatment of the gold ores of Hog Mountain, Alabama: Trans. Am. Inst. Min. Eng., vol. 39, 1909, pp. 578–583.

During 1908 the production of gold in Georgia was 2,719.01 fine ounces, valued at $56,207, and the production of silver 200 fine ounces, valued at $106, the total value of the precious metal output for the year being therefore $56,313. By comparison with the corresponding figures for 1907 a decrease is noted of 416.08 fine ounces in quantity and of $8,601 in value of gold, and of 664 fine ounces in quantity and of $464 in value of silver. There was no production of copper or lead in Georgia in 1908, the only mine yielding these metals having been continuously closed down throughout the year. The production of gold from placers in 1908 was 541.85 fine ounces, and of silver 42 fine ounces. The remainder of the output of precious metals, 2,177.16 fine ounces of gold and 158 fine ounces of silver, was all from siliceous ores, of which there were 6,196 short tons mined, yielding an average extraction valued at $7.28 per ton. There were 34 mines actively operated during the year, of which 22 were placers and 12 were deep mines.

The Appalachian gold belt crosses the northwestern portion of Georgia and includes parts or all of Carroll, Cherokee, Cobb, Fannin, Forsyth, Hall, Haralson, Lincoln, Lumpkin, McDuffie, Murray, Towns, Union, White, and Wilkes counties. Within this broad belt in Georgia are several well-defined smaller belts, as mentioned by Becker [a] and the Georgia State Geological Survey.[b]

The best defined of these has been called the Georgian belt by Becker and the Dahlonega belt by the Georgia Survey. At Acworth it splits into two branches, which extend through Cobb, Paulding, and Haralson counties on the north and Cobb, Paulding, and Carroll counties on the south, and probably include all three of the gold belts of Alabama farther to the southwest. To the northeast from Acworth the Dahlonega belt is from 2 to 8 miles broad and extends through Cherokee, Forsyth, Dawson, Lumpkin, White, and Rabun counties into North Carolina. The belt is broadest between Dahlonega and Nacoochee and tapers out in crossing the line into North Carolina. Northwest and southeast of the Dahlonega belt are isolated elliptical gold-bearing areas with their major axes striking northeast, and to the southeast are two parallel belts of less extent, the farthest one lying only 20 miles from the "fall line" and crossing McDuffie and Lincoln counties into South Carolina. The rocks associated with the gold deposits of Georgia consist chiefly of metamorphosed igneous and sedimentary rocks, probably of pre-Cambrian age, intruded by early granites, and much later, probably Triassic, diabase. The gold belts are in the eastern hills of the Blue Ridge and in the Piedmont Plateau. To the northwest are the Paleozoic rocks, including the beautiful Georgia marbles, and to the southeast of the "fall line" lie the younger formations of the Coastal Plain.

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[a] Becker, Geo. F., Reconnaissance of the gold fields of the southern Appalachians: Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1895, pp. 251–331.

[b] Yeates, W. S., and others, A preliminary report on a part of the gold deposits of Georgia: Bull. Geol. Survey Georgia, No. 4–A, 1896.
Jones, S. P., Second report on the gold deposits of Georgia: Bull. Geol. Survey Georgia, No. 19, 1909.

REVIEW BY COUNTIES.

Mine production of gold and silver in Georgia in 1908, by counties, in fine ounces.

County.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Value.
Carroll	8.66	$179		
Cherokee and Forsyth	1,522.70	31,477	35	$18
Lumpkin	546.83	11,304	70	37
White	103.71	2,144	11	6
McDuffie, Union, and other counties	537.11	11,103	84	45
	2,719.01	56,207	200	106

Carroll County.—In Carroll County there was a small production of placer gold from near Villarica in 1908.

Cherokee County.—The Dahlonega gold belt extends from southwest to northeast through the central portion of Cherokee County, southeast of Etowah River for the greater part, and is here defined by a considerable number of gold and pyrite deposits, among the former being the Franklin mine, the largest producer in the State. Among the nonproducing mines in 1908 were the Cherokee, Rich, Sixes, and Wilkey mines, and the Chattahoochee iron lead; the producing properties were the Farrar, Franklin, Southern Star, and Worley mines. The Cherokee mine, in the southern part of the county, has been developed mainly by 2 vertical shafts about 150 feet deep, by a crosscut, by drifts to northeast and southwest, and by stoping to near the surface. The associated rocks are chiefly hornblende and mica schists, and there are 2 veins, from 1 to 4 feet wide, of quartz with free gold and gold-bearing pyrites occurring together. The ore is in shoots pitching to northeast in veins dipping to the southeast. Faulting has slightly displaced the veins. A complete 10-stamp mill and cyanide plant in poor state of preservation is on the property. At one time an extensive hydraulic plant was in use and a large portion of a hillside was sluiced down in an attempt to work some of the disintegrated gold-quartz stringers in the schist. Considerable gold has been taken from the oxidized zone of the Cherokee mine, but of later years apparently at prohibitive expense, owing to high cost of fuel. The property has not been worked for several years. The Rich copper mine, near Canton, has been developed by an adit, 3 vertical and inclined shafts from 100 to 300 feet deep, and stopes. The ore is iron and copper pyrites and zinc sulphide, carrying small quantities of gold and silver, in a quartz gangue. Like most of the other deposits of the Dahlonega belt, the Rich mine is on or near the contact between hornblende schists and light-colored gneisses and mica schists. At one time considerable copper ore was shipped from this mine, but it has been idle for many years. The Sixes mine, in the southwestern part of the county, is also on the contact between hornblende schist and gneiss. The veins are apparently a series of stringers of quartz lying in a 3-foot garnet-chlorite schist zone between the hornblende schist below and a granite gneiss above. The ore is free gold and gold-bearing iron and copper pyrites. The Sutalee shaft was sunk 100 feet through granite gneiss, where it cut the contact zone in which some mining was done.

There is another shaft to the northeast 85 feet on an incline, in which quartz lenses 7 feet wide were cut. In Owl Hollow and Bell Hollow, just below the hornblende granite schist contact near by, a large amount of placer gold was washed out in early days. There is a 10-stamp mill with Wilfley concentrators on the property. The Sixes mine has been idle for a number of years. The Wilkey or Blake mine is a pyrite deposit in the northeast portion of the county, near the Franklin mine. The ore body is a strong shoot from 2½ to 8 feet wide dipping to the southeast and pitching northeast. The walls are of hornblende and mica schists. The mine has been developed by a 2-compartment inclined shaft on the pitch of the ore shoot, by a vertical shaft, and by drifts and stopes. The ore body is marked by strong gossan croppings, and below is almost solid crystalline pyrite. The output is shipped to sulphuric acid and fertilizer plants. Owing chiefly to market conditions there was no production from this mine in 1908. The "great Chattahoochee iron lead" is a remarkably well-defined outcropping from 8 to 20 feet wide, extending for several miles on the north side of the Etowah, about midway between Hickory Log Mountain and the river, and roughly parallel with the latter and with the strike of the schistosity of the country rocks and of the gold belt. It has been prospected as an iron-ore deposit, and a good many years ago some iron ore was shipped from one of the surface prospects. The ore body uncovered has the appearance of a gossan rather than of an original deposit of brown iron ore, and may lead to important sulphide deposits in depth. A continuation along its present outcrop would probably strike the Wilkey and Franklin pyrite deposits to the northeast. The Farrar mine, about 3 miles to the southwest of the Rich copper mine, produced a small amount of gold in 1908 from a mill-run test of ore from a quartz vein said by Jones [a] to be in mica schists.

The Franklin mine at Creighton, in the northeastern part of the county, was operated throughout the year. This famous old mine has been an important producer of gold since 1840, and now ranks third among Appalachian mines in order of production of gold. The principal work done in 1908 was in shaft No. 3½, which was deepened 350 feet and from which considerable drifting, crosscutting, and stoping were done. The oldest and deepest workings of this mine, in shafts Nos. 1 and 2, were flooded in the latter part of 1907, when Etowah River broke into the mine. It had been planned to make an increased production in 1908 from ore bodies unstoped when work had last been done here. The old workings extended to a vertical depth of 500 feet, or 1,000 feet down the pitch of the ore shoots. Shaft No. 3 is now 325 feet deep; shaft No. 3½, 525 feet; and shaft No. 4, 876 feet—all on the pitch of the ore shoots. There are several well-defined veins on this property, of which the McDonald and the Franklin are the best known. Two parallel diabase dikes, one of them a mere ribbon, cut across the ore body in shaft No. 3½, but neither displaced nor enriched the ore. The gold occurs free and with sulphides in white quartz gangue, and the deposits are in linked shoots set off en échelon, as if by slight step faulting or folding of the rocks before deposition was completed. This structure of the workable deposits was undoubtedly the cause of some confusion in early mining. The ore is associated chiefly with micaceous schists. Immediately

[a] Jones, S. P., op. cit., p. 155.

to the southeast of these are granite gneisses over a considerable area. The product of the mines is now treated in a 10-stamp amalgamating mill with Frue vanners, the concentrates being roasted and chlorinated. A new dam across the Etowah, just above the mill, has furnished an increased supply of water power, and mining and milling costs are relatively low, notwithstanding the long service of the mill and its need of repair. To the southwest of the gold veins and parallel with their strike deposits of pyrite have been prospected, but there was no production in 1908. There have been frequent references to the Franklin mine in recent years.[a]

The Southern Star mine, in the southwestern part of the county, produced pyrites only in 1908. A series of four parallel veins, about 150 feet apart, striking N. 35° E. with the schistosity, and dipping about 65° S. 55° E., have been prospected. The upper one containing gold in quartz lenses was worked many years ago, producing some good free-milling ore down to water level, where the pyritic ore was found unprofitable. The lower veins contain some narrow quartz lenses carrying pyrite, but consist chiefly of narrow bands of pure pyrite conformable with the schistosity of the rocks. The plant, originally designed for the extraction of gold, includes a Huntington mill and 3 tables. The concentrates are almost pure pyrite and are shipped to a fertilizer plant in Atlanta. There was no production of gold in 1908. The Worley mine is in the southeastern portion of Cherokee County along the boundary between the hornblende schists and a considerable area of granite and granite gneiss, apparently intrusive, lying southeast of the Dahlonega gold belt and extending to the northeast near Creighton. The veins are fissure fillings in gneissoid granite near the contact with the hornblende schists. Their form is that of lenses, one system of which strikes to the northwest and dips northeast, the other system striking nearly east and dipping a little east of south. The veins are from 1 to 6 feet thick and consist mainly of quartz carrying gold and pyrite. For 60 feet the ores are oxidized and free milling. Below this they are refractory sulphides. The deepest shaft is down 165 feet, and from this 2 levels have been driven in ore. A 1-stamp mill has been run for prospecting purposes, and in 1908 a small production of gold was reported. In this, as in all the mines noted in Cherokee County, the first production was from surface workings, chiefly of placer ground.

Cobb, Dawson, and Fannin counties.—There was no production from Cobb, Dawson, and Fannin counties in 1908.

Forsythe and other counties.—In Forsythe County there was a small placer production, but there was no output reported for the year from Gilman, Greene, Hall, Haralson, or Lincoln counties. In the last county the Seminole mine, which has produced gold, silver, copper, and lead, and has been described by Watson,[b] was closed down during the entire year.

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[a] Becker, Geo. F., op. cit., pp. 47–49.
Nitze, H. B. C., and Wilkens, H. A. J., The present condition of gold mining in the Southern Appalachian States: Trans. Am. Inst. Min. Eng., vol. 25, 1896, pp. 757–762.
Yeates, W. S., and others, op. cit., pp. 175–182.
McCaskey, H. D., Mineral Resources U. S. for 1907, pt. I, 1908, p. 559.
Jones, S. P., op. cit., pp. 159–166.

[b] Watson, Thos. L., The Seminole copper deposit of Georgia: Bull. U. S. Geol. Survey No. 225, 1904, pp. 182–186.

Lumpkin County.—In Lumpkin County there were, as usual, a considerable number of small placer operations in the decomposed rock in place and in the gravels in the vicinity of Auraria and of Dahlonega. There has been but little deep mining in Dahlonega for several years, the Singleton mine, leased by William Campbell from the Standard Gold Mining Company, being the only producer of importance. In Auraria the old Betz mine (also known as the Etowah or Piedmont mine), was actively developed by the Piedmont Mining and Milling Company by open cuts and by inclines, the deepest of which is now 440 feet on the incline. The plant consists of ten 450-pound stamps, four 5-foot Huntingdon mills, and 2 Wilfley tables, all operated by electricity generated by water power. Active work began in May and there was an important production reported at the close of the year. The Battle Branch mine was operated but a short time and the production was small. On Chestatee River, southeast of Dahlonega, the Dahlonega Gold Mining and Milling Company made the most important production of the county for 1908, operating the Briar Patch placer and the Calhoun mine. This company has been doing active development for several years, working a small dredge on the river, and prospecting and developing several veins. There are several good references to the Dahlonega district.[a]

McDuffie County.—In McDuffie County the old Hamilton mine, first worked in 1828 and operated as a surface mine successfully until the civil war, has had some prospecting work done upon it, but there was no production from it in 1908. There is some ore on the dump awaiting further development of the property. The vertical shaft is 200 feet deep. The Columbia mine was also idle. The incline shaft of this mine is 450 feet deep and there are about 2,000 feet of drifts. The plant includes a 10-stamp mill. The Parks mine was an important producer throughout the year. An incline shaft was sunk 100 feet and a drift was run 225 feet. The plant includes a 10-stamp mill. The ore is in part free milling, but a large part of the gold is in pyrites. The production in 1908 was from free gold only, the concentrates having been stored for future treatment. The mines of this county mentioned above have been briefly described by W. H. Fluker, the manager of the most important of them,[b] and by the Georgia State Survey.[c]

Oglethorpe and other counties.—In Oglethorpe, Paulding, Raburn, and Towns counties there was no production reported for 1908.

Union County.—In Union County there was a very small production from the Gumlog mine, but the Coosa Creek and Legal Tender mines were not worked.

White County.—In White County the Blow dredge that has produced considerable gold near Nacoochee in previous years was idle in 1908. The Henderson, Hamby & Reynolds, and Nacoochee placer

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[a] Becker, Geo. F., op. cit., pp. 50–53.
Nitze, H. B. C., and Wilkens, H. A. J., op. cit., pp. 721–722, 741–757.
Yeates, W. S., and others, op. cit., pp. 265–526.
Eckel, E. C., Gold and pyrite deposits of the Dahlonega district: Bull. U. S. Geol. Survey No. 213, 1903, pp. 57–63.
Lindgren, W., The gold deposits of Dahlonega, Ga.: Bull. U. S. Geol. Survey No. 293, 1906, pp. 119–128.
Jones, S. P., op. cit., pp. 173–205.

[b] Fluker, W. H., Gold mining in McDuffie County, Ga.: Trans. Am. Inst. Min. Eng., vol. 33, 1903, pp. 119–125.

[c] Jones, S. P., op. cit, pp. 81–95.

mines were also idle through the year. The Loud mines, the most important placers of the county, were acquired by R. K. Reaves, jr., from the Canadian-American Loud Mines Company, and continued production under the new management.

MAINE.

There are a number of prospects in Maine from which news has come from time to time, but so far as known there has been no great production from them in recent years of the metals discussed in this report. Sandy River, in Franklin County, has been credited by newspapers with the production of considerable placer gold. In Hancock County, on the coast, are the old Blue Hill,[a] Deer Isle, and Sullivan mines. The first has produced considerable copper in the past; the second has recently shipped zinc ore; and the third contains, according to Kempton,[b] rich silver-gold ore, associated with copper and lead sulphides.

The Sullivan mine is described by Kempton as lying near the contact of pre-Cambrian slates and intrusive granite—geologic relations common in Appalachian deposits. In Oxford County the Houghton mine is reported as a gold prospect, and preparations are said to have been made at Rumford Falls to treat gold gravels reported in the bed of Swift River. In Somerset County, near the town of Solon, the Robinson silver-lead-zinc prospect is equipped with a newly erected concentration plant.[c]

From Washington County the Millbridge Mining Company, successors to the Cherryfield Mining Company, reported no production from the Cherryfield mine in 1908. The old workings were cleaned out, however, on the 100-foot and 200-foot levels, and preparations were made for the remodeling of the concentrating plant. The ores are zinc and silver sulphides. In this county, at West Pembroke, is another prospect, showing low-grade copper-lead-zinc sulphides.[d] In this county also, near Gouldsboro, is a silver prospect, under bond to the Millbridge Mining Company, upon which development work was done in 1908. The Lubec mine, near Eastport, whose ores are lead-silver sulphides, and which is equipped with a large mill, was idle during the year.

MARYLAND.[e]

In Maryland three copper-bearing belts have been distinguished by the Maryland Geological Survey[f] and by Weed[g] and a gold-bearing district has been described by Emmons[h] and by Weed[i] and mentioned by the Maryland Survey.[j] Of the copper belts the most western extends from New London, Frederick County, through Liberty to Union Bridge, Carroll County; the second from Sykesville to Finksburg, both in Carroll County; and the third lies in the Bare Hills near

[a] Smith, G. O., Bastin, E. S., and Brown, C. W., Penobscot Bay folio (No. 149), Geol. Atlas U. S. Geol. Survey, 1907, p. 13.

[b] Kempton, C. W., Sketches of the new mining district at Sullivan, Me.: Trans. Am. Inst. Min. Eng., vol. 7, 1879, pp. 349–356.

[c] Mining World, vol. 28, Correspondence from Concord, Me., April 11, 1908, p. 614.

[d] Smith, G. O., Note on a mineral prospect in Maine: Bull. U. S. Geol. Survey No. 315, 1907, pp. 118–119.

[e] In the canvass for figures of production the cooperation of the Maryland Geological Survey is hereby acknowledged by the United States Geological Survey.

[f] Clark, W. B., and Matthews, E. B., Maryland mineral industries: Maryland Geol. and Econ. Survey, spec. pub., vol. 8, pt. 2, 1908, pp. 151–152.

[g] Weed, W. H., The copper mines of the world, Hill Pub. Co., New York, 1907, pp. 267–268.

[h] Emmons, S. F., Notes on the gold deposits of Montgomery County, Md.: Trans. Am. Inst. Min. Eng., vol. 18, pp. 391–412.

[i] Weed, W. H., Notes on the gold veins near Great Falls, Maryland.: Bull. U. S. Geol. Survey No. 260, 1905, pp. 128–131.

[j] Clark, W. B., and Matthews, E. B., op. cit., pp. 150–151.

Baltimore. The ore deposits in the first lie along the contact of metamorphic limestones, slates, and igneous rocks, and those to the east are said to be entirely in crystalline schists. The surface ore is often malachite, but in the shallow depths to which the workings go bornite and small quantities of chalcopyrite are found. The gold deposits are quartz fillings of fissures in the crystalline schists near Great Falls, and the gold is found free and with pyrites. The ore shoots are quite irregular in distribution, and although some have been rich, mining has so far been chiefly of an exploratory kind.

There was no production of copper, silver, or gold from Maryland in 1908. The Liberty mine, near Union Bridge, was closed throughout the year. From the concentrates shipped from this mine in 1907 however, some copper, taken account of in the report on the mine production in the Eastern States for that year, was produced by the smelters in 1908. During the year the New London copper mine near the town of that name and owned by the Linganore Copper Company, of Frederick, was cleaned out and some ore was hand sorted and stored for shipment. The deposit is of bornite and chalcocite in dolomite gangue near the contact of epidote schist and dolomite. The ore can apparently be readily concentrated, and preparations were made in 1908 for the development of the mine and the erection of a concentrating mill. The Anderson and the Maryland gold prospects near Great Falls were both idle in 1908. There was some experimenting with new machinery for treating ores of the former. The latter mine is opened by 2 shafts 155 and 210 feet deep and is equipped with a 10-stamp mill.

MASSACHUSETTS.

In Massachusetts there are some old lead-silver and lead-zinc prospects in Essex and Hampshire counties and some pyrite mines in Franklin County. From the latter only was there production in 1908, the output being a small quantity of copper incidental to the production of iron pyrites.

In Essex County, near Newburyport, are the old lead-silver mines operated in a small way in colonial times, but chiefly by the Merrimac and Lawrence mining companies from 1874 until 1880, when they produced a considerable output of rich argentiferous galena.[a] The veins are said to lie near the lines of contact of limestone and crystalline schists on the one hand and of granite and diorite on the other.[b] The ore minerals were limonite, siderite, malachite, azurite, galena, tetrahedrite, sphalerite, and pyrites, carrying gold and silver, and the gangue was principally quartz. Of late years some efforts were made to renew operations at the Merrimac mines, but since the recent industrial depression nothing seems to have been done. In Franklin County near Rowe, are the Davis and Davenport pyrite mines whose ores contain small quantities of copper occurring in chalcopyrite and cupriferous pyrite. The Davis mine, described by Rutledge [c] in detail, and elsewhere in Survey reports by Phalen, [d] is an important producer of pyrites. The Davenport mine, operated

[a] Hovey, Horace C., The lead and silver mines of Newbury: Sci. Am. Suppl., 1901, p. 21, 284.

[b] Clapp, C. H., and Ball, W. G., The lead-silver deposits at Newburyport, Mass., and their accompanying contact zones: Econ. Geology, vo. 4, 1909, pp. 239–250.

[c] Rutledge, J. J., Davis pyrites mine, Massachusetts; Eng. and Min. Jour., vol. 82, 1906, pp. 673–676, 724–727, 772–774.

[d] Phalen, W. C., The production of sulphur and pyrite in 1908; Mineral Resources U. S. for 1908, U. S. Geol. Survey, 1909.

by the New England Mining Company, is equipped with a 30-ton furnace and produced in 1908 a small output of copper in the form of matte.

In Hampshire County near Northampton are a number of lead-zinc prospects that have long been idle. They were described many years ago by Silliman[a] and Nash.[b] The veins are in granite intrusive in crystalline schists and are chiefly banded fissure veins. The ores are mainly galena and sphalerite, with occasionally chalcopyrite or cupriferous pyrite; the gangue is most often quartz, although barite and calcite are also found. The metalliferous veins appear, from the early descriptions, to cut the overlying metamorphic schists in some cases. The pegmatite veins and granite contain beryls and precious garnets.

NEW HAMPSHIRE.

In Carroll, Coos, Grafton, Merrimack, and Sullivan counties in New Hampshire are a number of old mines that have mainly produced copper, lead, and zinc from sulphide ores at various times, and there have also been some gold prospects; but the only mine active in 1908 was that at West Milan, in Coos County, from which there was an important output of copper. Much detailed information concerning early prospecting and mining in this State is given by Hitchcock,[c] and his mention of the frequent occurrence of small quantities of gold in conglomerate near Landoff, Lisbon, Lyman, and North Haverhill in Grafton County is especially interesting. The ore deposits appear to be similar in most respects to those of the southern Appalachians, in that they are in lenticular fissure fillings in the ancient crystalline and associated granitic rocks. The auriferous conglomerate of Hitchcock also suggests certain characteristics of the Devils Backbone of Alabama, described by Phillips as a gold-bearing sandstone.[d] Although there has been production, temporarily promising in some instances, of gold, silver, copper, lead, and zinc, mining and metallurgy have been but little developed in New Hampshire, and the value of many of the numerous prospects remains uncertain. It is probable that the limited extent of the ore shoots has proved most of the properties to be unprofitable; but as mining has gone to little depth and as many mines could not be made to pay because of unsatisfactory methods employed, it is also possible that in New Hampshire, as elsewhere in the Appalachians, some profitable mining may still be looked for.

In Carroll County the principal ore deposits known are the "silver mine" near Ossipee, in which the ores are galena, blende, and iron and copper pyrites in a quartz gangue in granite gneiss; and the Madison silver-lead-zinc mine, described by Hitchcock as in quartzite,[e] which at one time had a considerable production.

In Coos County alluvial gold has been found in small quantities along Indian Stream, near the Quebec line. Near Shelburne, silver-lead-zinc ores with pyrite, occurring in a quartz gangue in micaceous schists have been worked by different companies but apparently

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[a] Silliman, Benjamin, Particulars relating to the lead mine near Northampton, Mass.; Am. Min. Jour., vol. 1, 1814, pp. 63–69.

[b] Nash, A., Notices of the lead mines and veins of Hampshire County, Mass., and of the geology and mineralogy of that region; Am. Jour. Sci., 1st ser., vol. 12, 1827, pp. 238–270.

[c] Hitchcock, C. H., The geology of New Hampshire, pt. 5, 1878, pp. 1–69.

[d] Phillips, W. B., A preliminary report on a part of the lower gold belt of Alabama; Bull. Geol. Survey Alabama No. 3, 1892.

[e] Hitchcock, C. H., op. cit., pp. 62–63.

never at a profit. Near Gorham is the silver-lead-zinc-copper mine of the Mt. Hayes Silver-Lead and Copper Company, with about 1,000 feet of underground work, which produced in 1907. Near West Milan the Milan Mining and Milling Company began important development work in 1907 and made several shipments of copper ore in 1908, one-fourth the value of which was in precious metals, the values of gold and silver being nearly equal. A 200-ton concentrating plant, containing 3 Dodge crushers, 2 rolls, 5 Wilfley tables, and 1 Richards pulsator jig and classifier has been erected, and a large supply of ore was reported ready for milling by the end of 1908. J. B. Carper, manager of the mine, published a statement [a] to the effect that a trial shipment of two carloads of ore showed the following analysis: Copper, 8 per cent; gold, 0.08 ounces, and silver, 4.00 ounces, per ton; iron, 31.83 per cent; silica, 7.8 per cent; and sulphur, 38.18 per cent. Later shipments to smelters showed values in metallic contents of $8 to $10 per ton. The ores are sulphides of iron and copper in crystalline schists.[b]

In Grafton County, at Woodstock, a deposit of lead-zinc sulphides in a fissure in gneiss [c] was worked during all of 1906, but difficulty was found in satisfactory ore dressing; and discouragement followed the industrial depression of 1907. A shaft was sunk 175 feet, and a 100-ton mill was erected for producing marketable concentrates. At Warren a silver-lead-zinc deposit, the ores of which have proved difficult in treatment,[d] has also recently been worked. According to Hitchcock,[e] the ores are associated with tremolite and quartz and are inclosed in mica schist lying within gneiss. Copper ores were first conspicuous in the tremolite, but they appear to have given way in depth to zinc blende with smaller quantities of galena. The ore is in a well-defined shoot. The immediate presence of trap dikes is noted in this case by Hitchcock as in that of many other New Hampshire mines.

Six copper mines have also been described by Hitchcock on Gardner Mountain at Bath, Monroe, Lyman, and Littleton.[f] The rocks are crystalline schists, and the ores are copper carbonates and chalcopyrite, with associated argentiferous galena, zinc blende, and pyrrhotite with quartz gangue in fissure fillings. There seems to have been considerable gold in some of the pyrrhotite. Cross fissures have been noted in the Paddock mine, one of them reported to be richer in copper than the main vein, and another said to contain silver-lead ores. In some of these ore deposits, again, copper ores apparently give way to lead and zinc sulphides in depth. These mines have been idle for many years.

The presence of gold in many places in a conglomerate near Lyman and elsewhere in this county has already been noted. Gold is also found in notable quantity, according to Hitchcock,[g] in some of the sulphides already described, but it has not yet been extracted with profit from them. The Dodge mine, near Lyman, and the Lisbon mine, near the town of that name, appear to have been in gold-quartz veins in clay slates, and the ore was free-milling down to water level and changed to auriferous sulphides below. These veins

[a] Eng. and Min. Jour., vol. 87, 1909, p. 318.
[b] Hitchcock, C. H., op. cit., pp. 47–48.
[c] Letter from F. W. Hunton, of the Hunton Mining Company, to J. M. Boutwell, 1907.
[d] Boutwell, J. M., Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, p. 466.
[e] Hitchcock, C. H., op. cit., pp. 48–49.
[f] Hitchcock, C. H., op. cit., pp. 35–47.
[g] Hitchcock, C. H., op. cit., pp. 23–27.

were characterized by ore shoots pitching to the northeast as is common in Appalachian mines. The ores seem to have yielded from $6 to $20 per ton in free-milling gold, and these two mines produced about $50,000 from 1868 to 1878. The ore was treated in two 10-stamp mills.

In Merrimack County near Pittsfield is the old Silverdale mine, in which silver-lead ores occur with a quartz gangue in gneiss. Pyrite and chalcopyrite are found with the galena. There was at one time a furnace near by to treat the ores from this and adjoining prospects, but the production was probably small.

In Sullivan County Hitchcock [a] notes cupriferous pyrite, pyrrhotite, and chalcopyrite ores in the crystalline schists at Croydon and Unity in deposits apparently of considerable extent. Prospecting, however, has not fully developed their value.

NEW JERSEY.[b]

In New Jersey there are a number of copper deposits in the "Red Beds" of the Triassic, usually adjacent to trap flows, but little production has been derived from them for many years. They have been frequently described, more recently by Weed,[c] Lewis,[d] Kümmel,[e] and others. Among these are the Griggstown, Arlington, Flemington, Somerville, Pahaquarry, and New Brunswick mines, near the places of those names. Of these the Arlington, or Schuyler, mine was successfully worked at various intervals from colonial times until recent years, and the Griggstown and others were also productive in early days. In some cases extensive underground work has been done, as at the American, or Somerville, mine, where the inclined shaft has been sunk to a depth of 2,360 feet, and concentrating and smelting plants have been erected. There is reason to believe that impregnation of the sedimentary rocks has been extensive and that large ore bodies can be found, but their low grade and the difficulty in cheap treatment have prevented success in recent years. The ores are chiefly chalcocite, native copper, and chalcopyrite, altered near the surface to chrysocolla, cuprite, and malachite. The problem involved seems to be the successful handling of large quantities of low-grade ore occurring in relatively thin beds.

The only production in New Jersey in 1908 with which this report is concerned was that of zinc by the New Jersey Zinc Company in their mines at Mine Hill, near Franklin Furnace, Sussex County. The mines of this company at Sterling Hill, near Ogdensburg, in the same county, were not operated in 1908. During the year 56,764 tons of concentrates were produced, as smelting ore, and yielded 45,354,430 pounds of spelter, valued at $2,131,658. This shows a production more than double that of 1907. In addition an important production was made of zinc oxide. The ore minerals

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[a] Hitchcock, C. H., op. cit., pp. 49–51.

[b] In obtaining figures for 1908 cooperation with the state geologist of New Jersey is hereby acknowledged by the United States Geological Survey.

[c] Weed, W. H., The copper mines of the world, New York, 1907, pp. 266–267. Copper deposits of the Appalachian States: Bull. U. S. Geol. Survey No. 213, 1902, pp. 182–183. Copper deposits of New Jersey: Ann. Rept. State Geologist, Geol. Survey New Jersey, 1903. The Griggstown, N. J., copper deposit: Bull. U. S. Geol. Survey No. 225, 1903, pp. 187–189.

[d] Lewis, J. V., Copper deposits in the New Jersey Triassic, Econ. Geology, vol. 2, 1907, pp. 242–257. The Newark (Triassic) copper ores of New Jersey: Ann. Rept. State Geologist, Geol. Survey New Jersey, 1906, pp. 131–164.

[e] Kümmel, H. B., Ann. Rept. State Geologist, Geol. Survey New Jersey, 1903, pp. 109–111 (and other annual reports).

are chiefly franklinite, willemite, and zincite, associated with other silicates of manganese and zinc in minor quantity, and with calcite, rhodonite, garnet, pyroxene, and hornblende. The ore is wholly confined to the white pre-Cambrian Franklin limestone, a fact well emphasized by Kümmel,[a] in view of the possibility that large sums may be lost in fruitless exploration elsewhere. The geology of the deposits has been recently given by Spencer [b] in considerable detail. Briefly, the two ore bodies, situated about 2½ miles apart, are in the form of deep and narrow scoops with the points lying southerly and the keels rapidly gaining depth to the north. These scoops lie entirely in the Franklin limestone, and these outcrops show hook-shaped horizontal traces. The sides of the scoops, or troughs, are of unequal height, and the thickness of the ore bodies varies from 10 to 30 feet in the Sterling Hill deposit and from 12 to 100 feet or more in that of Mine Hill.

The mines were prospected as early as 1650,[c] and in 1774 several tons of zincite were shipped to England. In 1838 the first spelter made in the United States was smelted from zincite from these mines and used in making the first brass set of standard weights and measures for the Government. From this time to 1860, however, the chief product was an oxide of zinc, used as a paint. Not until 1896, when the Wetherill magnetic process was perfected, was the ore dressing in the New Jersey mines satisfactory, although the metallurgical principles now followed are of much earlier date. The mines now produce, through concentrating mill and smelter, a high grade of spelter, zinc oxide, and spiegeleisen. The Wetherill concentrators yield three products from the Mine Hill ores—franklinite, "half-and-half," and willemite. Of these, the first is used in making zinc oxide and leaves a residue that goes to the blast furnace to make spiegeleisen; the second is also used for making zinc white, but its residue is too high in silica for the blast furnace; and the third, after jigging, further concentrating, and smelting, yields high-grade spelter. The zinc deposits and mining industry have recently been frequently described.[d]

NORTH CAROLINA.

Mine production of gold, silver, and copper in North Carolina in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Pounds.*		
1907	3,976.08	$82,193	21,667	$14,300	582,082	$116,416	$212,909
1908	4,716.32	97,495	1,260	668	19,393	2,560	100,723
Increase (+) or decrease (−)	+740.24	+15,302	−20,407	−13,632	−562,689	−113,856	−112,186

[a] Kümmel, H. B., Ann. Rept. State Geologist for 1907, Geol. Survey New Jersey, 1908, pp. 172–173.
[b] Spencer, A. C., Franklin Furnace folio (No. 161), Geol. Atlas U. S., U. S. Geol. Survey, 1908, pp. 24–25.
[c] Spencer, A. C., The Mine Hill and Sterling Hill zinc deposits of Sussex County, N. J.: Ann. Rept. State Geologist for 1908, Geol. Survey New Jersey, 1909, pp. 23–52.
[d] Kemp, J. F., The ore deposits at Franklin Furnace and Ogdensburg, N. J., Trans. N. Y. Acad. Sci., vol. 13, 1893, pp. 76–98. (Gives good bibliography.) Ore deposits of the United States, fifth edition, 1903, pp. 251–257.
Spencer, A. C., Franklin Furnace folio (No. 161), Geol. Atlas U. S., U. S. Geol. Survey, 1903, pp. 24–25.
——— The Mine Hill and Sterling Hill zinc deposits of Sussex County, N. J.: Ann. Rept. State Geologist for 1908, Geol. Survey New Jersey, 1909, pp. 23–52.
Wolff, J. E., Zinc and manganese deposits of Franklin Furnace, New Jersey: Bull. U. S. Geol. Survey No. 213, 1909, pp. 214–217.
Kümmel, H. B., Ann. Repts. State Geologist, Geol. Survey New Jersey.

The production of the precious metals in North Carolina in 1908 was valued at $98,163, and the value of copper produced was $2,560, a total value of gold, silver, and copper for the year of $100,723. There has been no important production of lead or zinc reported from North Carolina in many years. But little interest has been shown of late in the few lead-zinc deposits known. The production of gold alone in 1908 was 4,716.32 fine ounces, valued at $97,495, an increase over the production of 1907 in this State of 740.24 fine ounces in quantity and of $15,302 in value. The output of silver and copper, always closely related in North Carolina, was greatly below the production of 1907. Of silver, the production was only 1,260 fine ounces, valued at $668, and of copper, only 19,393 pounds, valued at $2,560, decreases being shown of 20,407 fine ounces of silver, and of 562,689 pounds of copper, owing to the idleness of the principal copper mines in 1908. The total decrease in value of the production of the three metals named amounted to $112,186, or 53 per cent, as compared with the corresponding value for 1907. The decrease in value of copper production was $113,856, or 98 per cent, and in that of silver production $13,632, or 95 per cent. A resumption of copper mining at Gold Hill would probably restore the State to her former production of copper and silver. North Carolina easily maintains first place in the Eastern States in the production of gold.

In 1908, as in 1907, there were 26 placer mines in operation in North Carolina, but the number of deep mines was reduced from 17 to 16, the total number of producing mines being 42. The total ore tonnage raised from deep mines was 9,088 short tons, of which 9,070 tons were of siliceous gold ores and 18 tons were of copper ores. Of the total gold production, 849.23 fine ounces were from placers and 3,867.09 ounces were from deep mines. The production of silver from placers in 1908 was 114 fine ounces, and from deep mines 1,146 fine ounces. The value of the average extraction in precious metals (almost entirely of gold) from siliceous ores in North Carolina in 1908 was $8.88 per ton, an increase in value of 79 cents per ton.

There are a number of useful recent references to the general subject of the ore deposits of North Carolina.[a] In these references all of the principal mines have frequently been described, and further description will not be given at this time.

[a] Becker, George F., Reconnaissance of the gold fields of the southern Appalachians; Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1895, pp. 251–331. (Contains bibliography to 1895.)
Nitze, H. B. C., and Hanna, G. B., Gold deposits of North Carolina; Bull. North Carolina Geol. Survey No. 3, 1896.
Nitze, H. B. C., and Wilkens, H. A. J., The present condition of gold mining in the southern Appalachian States; Trans. Am. Inst. Min. Eng., vol. 25, 1896, pp. 661–796, 1021–1025.
Blake, W. P., Notes and recollections concerning the mineral resources of northern Georgia and western North Carolina; Trans. Am. Inst. Min. Eng., vol. 25, 1896, pp. 796–811.
Nitze, H. B. C., and Wilkens, H. A. J., Gold mining in North Carolina and adjacent southern Appalachian regions; Bull. North Carolina Geol. Survey No. 10, 1897.
Weed, W. H., Types of copper deposits in the southern United States; Trans. Am. Inst. Min. Eng., vol. 30, 1901, pp. 449–504. Notes on the Carolina gold deposits; Eng. and Min. Jour., vol. 72, 1901, p. 494.
Pratt, J. H., Gold mining in the southern Appalachians; Eng. and Min. Jour., vol. 74, 1902, pp. 241–242.
Weed, W. H., Recent development of southern copper deposits; Eng. and Min. Jour., vol. 74, 1902, pp. 80–81. Copper deposits of the Appalachian States; Bull. U. S. Geol. Survey No. 213, 1903, pp. 181–185.
Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians; Bull. U. S. Geol. Survey No. 293, 1906.
Pratt, J. H., The mining industry in North Carolina in 1906; Economic Paper No. 14, North Carolina Geol. Survey, 1907. (See also Economic Papers for preceding years.)
Eames, Richard, jr., Copper in North Carolina; Eng. and Min. Jour., vol. 83, 1907, p. 583.
Weed, W. H., The copper mines of the world, Hill Pub. Co., N. Y., 1907.
Crosby, W. O., Ore deposits of the eastern gold belt of North Carolina; Tech. Quart., vol. 20, No. 3, 1907, pp. 280–286; Trans. Am. Inst. Min. Eng., vol. 38, 1908, pp. 849–856.
Hafer, Claud, Notes on mining in North Carolina; Min. World, vol. 28, 1908, pp. 332–333.
Lyon, E. W., The progress of gold mining in North Carolina; Eng. & Min. Jour., vol. 87, 1909, pp. 293–297.
Pratt, J. H., New type of washer for low-grade gold ores; Eng. and Min. Jour., vol. 87, 1909, pp. 935–938.

The ore deposits of North Carolina may be fairly well grouped within five roughly parallel belts, as outlined by Nitze[a] some years ago, who described: (1) The eastern belt of metamorphic rocks in Nash, Franklin, and Halifax counties, lying between the sediments of the Coastal Plain on the east and the granites and other igneous rocks on the west; (2) the Carolina slate belt of crystalline schists and slates in Granville, Person, Alamance, Orange, Chatham, Randolph, Davidson, Montgomery, Rowan, Cabarrus, Stanly, and Union counties, bordered on the east by Triassic rocks and on the west by rocks of the following division; (3) the North Carolina igneous belt, chiefly of granites and diorites, in Guilford, Davidson, Rowan, Cabarrus, and Mecklenburg counties; (4) the Kings Mountain belt of gneisses, schists, and quartzites in Gaston, Lincoln, Catawba, Davie, and Yadkin counties; and (5) the South Mountain belt of schists, gneisses, and granitic rocks in Burke, McDowell, Rutherford, and Polk counties. These belts are given in order from east to west and lie for the greater part in the Piedmont Plateau.

REVIEW BY COUNTIES.

Mine production of gold, silver, and copper in North Carolina in 1908, by counties.

County.	Gold.		Silver.		Copper.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ozs.		*Fine ozs.*		*Pounds.*		
Burke	168.30	$3,479	29	$15	.....	.....	$3,494
Cabarrus	591.68	12,231	84	44	.....	.....	12,275
Catawba, Cleveland, and Gaston	215.37	4,452	46	25	.....	.....	4,477
Franklin and Guilford	8.32	172	2	1	.....	.....	173
McDowell	16.83	348	1	1	.....	.....	349
Mecklenburg and Montgomery	2,938.73	60,749	886	470	.....	.....	61,219
Orange, Person, and Rowan	508.03	10,502	179	95	19,393	$2,560	13,157
Rutherford	67.96	1,405	8	4	.....	.....	1,409
Stanly	50.94	1,053	9	5	.....	.....	1,058
Union, Polk, and others	150.16	3,104	16	8	.....	.....	3,112
Total	4,716.32	97,495	1,260	668	19,393	2,560	100,723

Anson, Ashe, Buncombe counties.—There was no production in 1908 reported from Anson, Ashe, and Buncombe counties.

Burke County.—In Burke County there was a small production of placer gold from several operators. The surface veins and gravels of the Mills mine were worked by the hydraulic method and produced both gold and crude monazite.

Cabarrus County.—In Cabarrus County the Linker mine was idle in 1908, but there were a number of other producers, notably the Meadow Creek and New Nugget placer mines, from which a considerable production of gold, partly in nuggets, was obtained. There was also a small output of gold and silver, resulting from the working of the old dumps of the Phoenix mine.

Caldwell County.—From Caldwell County there was no production reported in 1908.

[a] Nitze, H. B. C., and Hanna, G. B., Gold deposits of North Carolina; Bull. North Carolina Geol. Survey No. 3, 1896.

Catawba County.—In Catawba County the England, Peach Tree, and Shuford mines all produced small outputs of gold and silver during the year. The Catawba Gold Mining Company, operating the Shuford mine, continued trials of machinery preparatory to the erection of a plant for treatment at a low cost of surface ores. The method of handling will include cable tramway, clam-shell excavator, trommels, crushers, rolls, riffles, and blankets.

Cleveland County.—In Cleveland County there was a small recovery of placer gold by the Carolinas Monazite Company after the concentration of monazite sands.

Davidson County.—In Davidson County both the Silver Valley and the Silver Hill mines were idle in 1908. The latter mine is one of the oldest and deepest in the State, and, with the Silver Valley mine, 5 miles to the northeast, has furnished the chief supply of lead-zinc ores of North Carolina. The ores are gold and silver bearing galena and blende, with smaller quantities of pyrite and chalcopyrite, and the country rock is of schist.[a] The gossan was worked in the early days only for gold. The Emmons and Cid mines, of the Hercules Gold and Copper Company, were also idle in 1908. The former has been a producer of copper ores in recent years, and the company will probably resume operations. The Welborn mine did not produce in 1908.

Davie County.—The Gray mine, near Statesville, in Davie County, was operated for a short time only during the year, and no production was reported. The ore is wholly refractory.

Franklin County.—In Franklin County the production from the Portis mine was small, work upon this property having been confined to prospecting and development.

Gaston County.—In Gaston County a small production resulted from the reworking of ore dumps of the old King's Mountain mine and from other surface operations.

Granville County.—The Blue Wing and Copper King mines of the Virgilina district in Granville County were idle during 1908. The Virgilina district, extending for 10 miles from Halifax County in Virginia across the state line into Granville and Person counties, N. C., has been described in detail by Weed[b] and Watson.[c]

Guilford County.—In Guilford County the Deep River, Fentress, Oak Hill, Palachian, and Pine Hill mines were also idle, but there was a small output from the Hudson mine, near High Point.

Jackson County.—There was no production reported from any of the gold and copper prospects in Jackson County in 1908, but there was some development work done at the Cullowhee copper mine, and a 30-ton smelter and a 10-ton lixiviation plant were reported in course of erection.

Macon County.—There was no production reported from Macon County. Some prospecting is, however, reported to have been in progress, which showed the presence of both gold and silver ores.

McDowell County.—In McDowell County there was a small output of placer gold.

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[a] Kerr, W. C., and Hanna, George B., Ores of North Carolina: Geology of North Carolina, vol. 2, North Carolina Geol. Survey, 1888, pp. 193-199.

[b] Weed, W. H., Types of copper deposits in the Southern United States: Trans. Am. Inst. Min. Eng., vol. 30, 1901, pp. 452-470.

[c] Watson, T. L., Copper-bearing rocks of Virgilina copper district, Virginia and North Carolina: Bull. Geol. Soc. America, vol. 13, 1902, pp. 353-376.

Mecklenburg County.—There was but little activity among the many old mines and prospects of Mecklenburg County during the year. A considerable amount of prospecting was done by the Southern Placer Mining Company, and there was a small production from the Catawba River dredge, the Yellow Dog mine, and from ores of the St. Catherine-Rudisil group near Charlotte, which were sent to the Haile plant for trial; but the Capps, Frederick, Grier, Johnson, and Surface Hill mines were idle practically throughout the year.

Montgomery County.—A small quantity of placer gold, chiefly as nuggets, came from surface mines, but the main production of gold from Montgomery County, and from North Carolina, was derived, as usual, from the Iola mine. This property, the second largest producer of gold in recent years of the Appalachian States, is near Candor, and along the line of strike of the Montgomery and Golconda veins. Although one of the newest mines in the State, having been worked for only about eight years, the production in gold from this mine is already considerably over $300,000, a respectable showing in the Eastern States. The mine has been most recently described by Hafer[a] and Lyon.[b] The development has been mainly by 4 shafts and 5 levels, and the plant for treating the ore has been gradually increased until a 40-stamp mill, with concentrators and a 40-ton cyanide capacity, have been reached. The country rock has been described as a "greenstone of slaty character, probably a sheared andesite," by Lyon, and the vein from 2 to 6 feet wide seems to have been quartz at the surface, but a "slaty quartzite ore carrying some lime spar" in depth. The gold has been found free for the greater part in the vein, but the walls are impregnated with pyrites. The ore has been found in shoots and seems to have been particularly profitable near the surface, although Lyon states that in the two lowest levels, 255 and 327 feet deep, north and south from the No. 1 shaft, the richest ore in the mine has been found. The company recently underwent reorganization, but the output reported for 1908 was somewhat higher than in the two preceding years.

Moore County.—The Laufman mine and the properties of the Elise Mining Company, near Hemp, in Moore County, were not operated during 1908, and there was no production reported by the Argo Mining Company from their Nash County mines.

Orange County.—In Orange County, however, the Robertson mine, of the North State Mining Company, made a small output from the 10-stamp concentrating mill. The development work, begun in June, 1908, included a shaft 120 feet deep and 350 feet of drifts. The mill was only started up at the close of the year.

Person and Polk counties.—In Person County little was done in the Durgy and other mines of the Virgilina mining district; and in Polk County the Red Springs and Weatherby mines were idle, the production being confined to a small quantity of placer gold.

Randolph County.—In Randolph County there was no production in 1908 from the Boson, Empire, Redding, or Southern Homestake mines. The latter property, though but slightly developed, was equipped with a 100-ton milling and cyaniding plant only to prove disappointing by reason of low-grade ores and insufficient development of large bodies of them. A shut down followed the failure of the

[a] Hafer, Claud, op. cit., pp. 332–333. [b] Lyon, E. W., op. cit., pp. 295–296.

ores to pay for an expensive and apparently too hastily erected mill. The Scarlett copper mine has been practically closed since the fall in price of copper in 1907.

Rowan County.—In Rowan County the Gold Coin mine, of the Southern Mining Company, at Gold Hill, produced a small output of gold from the operation for two weeks of the 10-stamp concentrating mill. The main shaft is 180 feet deep, and about 700 feet of underground work was reported for 1908. The Park mine was shut down, and the well-known Union mines were closed. The Gold Hill mines were worked but a short time, pending reorganization of the company operating them, but produced some gold, silver, and copper. The failure in 1908 of these important copper mines of Gold Hill to make their usual important output greatly curtailed the copper production of the State. The Union copper mines have been recently described by Ledoux [a] and the Gold Hill mines in general by Weed [b].

Rutherford and Stanley counties.—There was a small placer production in Rutherford County, and the Double Branch mine yielded a small output of gold from ore obtained in development work. In Stanley County, also, there was but a small placer production in 1908.

Swain County.—There was no output reported from the Everett mine of the North Carolina Copper Mining Company in Swain County during the year.

Union and other counties.—In Union County production was confined to a small output of gold from prospecting the Davis mine, near Matthews, operated by the Winona Mining Company. The Phifer mine, on the Price tract of the holdings of this company, and the Black, Brewer, Indian Trail, and Union Mining and Milling Company mines, were all idle in 1908. There was also no production reported from any of the mines or prospects in Warren, Watauga, Wilkes, and Yadkin counties during the year.

PENNSYLVANIA.

There have been few deposits of copper, lead, or zinc ores yet proved to be of economical importance in Pennsylvania, and no gold or silver ores are known to occur, although gold was found in small quantities, according to Wherry,[c] in chalcopyrite occurring in the traps. Associated with the "Red Beds" of the Triassic in southeastern Pennsylvania, however, from Reading through parts of Berks, Chester, Montgomery, and Bucks counties to Delaware River, are a number of occurrences of low-grade copper ores, and there have been numerous attempts since colonial times, unsuccessful on the whole, to mine some of them at a profit. These deposits are similar in most respects to those in New Jersey of similar origin and age. These copper deposits have been recently described by Lyman[d] and Wherry.[e] The lead-zinc deposits at Phoenixville, in Chester County, at Audubon, in Montgomery County, and at New Galena, in Bucks

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[a] Ledoux, A. R., The Union Copper Mines, Gold Hill, North Carolina: Eng. & Min. Jour., vol. 69, 1900, pp. 167–170.

[b] Weed, W. H., Types of copper deposits in the Southern United States; II. The Gold Hill Type: Trans. Am. Inst. Min. Eng., vol. 30, 1901, pp. 470–479.

[c] Wherry, E. T., The Newark copper deposits of southeastern Pennsylvania: Econ. Geol., vol. 3, 1908, pp. 732–733.

[d] Lyman, B. S., Copper traces in Bucks and Montgomery counties: Jour. Franklin Inst., vol. 146, 1898, pp. 416–423.

[e] Wherry, E. T., op. cit.

County, though appearing in the area of the "Red Beds," are of somewhat different type, being in fissure veins mainly in the underlying gneiss, associated with granitic intrusives and cutting trap dikes, and therefore younger than them, according to Rogers,[a] but being cut by the traps according to Wherry.[b] The Wheatley mine, near Phoenixville, was extensively worked from 1800 to 1853 and was favorably reported upon by Rogers at the latter date. There has been no production known from it, however, in the last fifty years. Copper is found again in the "Red Beds" of Adams County[c] and in the ancient metamorphic rocks of South Mountain,[d] extending through Adams and Franklin counties into Maryland, and small quantities of the metal were obtained from shallow workings many years ago.

In Lancaster County, near Landisville, is the old Bamford silver-lead-zinc mine, described by Spilsbury[e] as a bedded deposit between white and blue Silurian limestones. This mine was first prospected in 1845 and was extensively worked for zinc oxide and spelter at various times to 1877. Ore-dressing machinery was imported from Wales, and smelting furnaces of the Belgian type were erected. In this county also is the Gap mine, near the town of that name, worked for copper prior to 1744 at various times and by various companies up to 1852, but usually at a loss. In the latter year the presence of nickel ore was discovered by Genth, and fresh attempts were made to work the new ore, but not successfully until in 1862 Joseph Wharton made mines and smelter a success and became the largest producer of nickel in America.[f] The ore is nickeliferous and cupriferous pyrrhotite, found along the contact between a lens of intrusive amphibolite and pre-Cambrian schists.[g] The mine has been abandoned since 1893.

In Lehigh County, near Friedensville, are the old Ueberroth, Hartman, and Saucon zinc mines of the Lehigh Zinc Company, in the magnesian limestone of Chazy age.[h] The ores are sphalerite, and the oxidized products, calamine and smithsonite. These mines were important producers from 1853 to 1876, but have had little production since, although there are occasional statements that they will be reopened. A high grade of spelter was produced.

The only production from Pennsylvania of gold, silver, copper, lead, or zinc, reported in 1908 was that of copper and a small quantity of gold from the reconcentration of tailings resulting from the magnetic dressing of the magnetite ores of the Cornwall mine in Lebanon County. The ores and ore body have been recently described by

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[a] Rogers, H. D., The geology of Pennsylvania, vol. 2, Philadelphia, 1858, pp. 699–705.

[b] Wherry, E. T., op. cit., pp. 736–737.

[c] Frazer, P., Appendix: Second Geol. Survey Pennsylvania, Vol. CCC, 1880, pp. 299–303; also The geology and the copper deposits of Adams County, Pa.: Eng. and Min. Jour., vol. 35, 1883, p. 112.

[d] Henderson, C. H., The copper deposits of South Mountain: Trans. Am. Inst. Min. Eng., vol. 12, 1884, pp. 85–90.

Bascom, F., The ancient volcanic rocks of South Mountain, Pa.: Bull. U. S. Geol. Survey No. 136, 1896, pp. 25–27.

[e] Spilsbury, E. G., in The geology of Lancaster County, by Persifor Frazer: Second Geol. Survey Pennsylvania, Vol. CCC, 1880, pp. 198–203.

[f] Doble, Charles, in The geology of Lancaster County, by Persifor Frazer: Second Geol. Survey of Pennsylvania, Vol. CCC, 1880, pp. 163–168.

[g] Kemp, J. F., The nickel mine at Lancaster Gap, Pennsylvania, and the pyrrhotite deposits at Anthonys Nose, on the Hudson: Trans. Am. Inst. Min. Eng., vol. 24, 1884, pp. 620–630; also Ore deposits of the United States and Canada, 5th ed., N. Y., 1903, pp. 432–434.

[h] Drinker, H. S., The mines and works of the Lehigh Zinc Company: Trans. Am. Inst. Min. Eng., vol. 1, 1871–1873, pp. 67–75.

Kemp, J. F., Ore deposits of the United States and Canada, 5th ed., N. Y., 1903, pp. 250–251.

Spencer.[a] The Cornwall deposit is a metasomatic replacement of Paleozoic limestones, and lies near the northern edge of the Triassic rocks in close association with intrusive sheets of diabase. This great ore body has yielded more than 21,000,000 tons of iron ore since 1853. The ore is mainly magnetite, with which occur small quantities of pyrite and chalcopyrite, and it is from the concentration of these latter minerals in the tailings that the production of copper was obtained. Analyses show the presence of from 0.005 to 0.599 per cent of metallic copper in the crude ore. Experimental shipments of copper concentrates will probably lead to the regular production of copper as a by-product.

SOUTH CAROLINA.

The production of South Carolina in 1908, as compared with that of 1907, showed a decrease of 50.80 fine ounces in quantity and of $1,050 in value of gold, but an increase of 102 fine ounces in quantity and of $38 in value of silver, and of 1,600 pounds in quantity and of $211 in value of copper. The total production of gold was 2,598.46 fine ounces valued at $53,715; the output of silver was 226 fine ounces valued at $120; and the production of copper was 1,600 pounds valued at $211. The value of the total production for 1908 was $54,046, as compared with a corresponding value of $54,847 for 1907. The production reported for 1908 was from 2 placers and 5 deep mines. During 1907 there were 5 placers and but 1 deep mine reporting production. The total quantity of ore reported from deep mines was 16,795 short tons, of which 16,776 tons were of siliceous gold ore yielding 2,556.28 fine ounces of gold and 65 fine ounces of silver, or an average extraction of $3.15 in value of gold and silver per ton treated; and 19 tons were of copper ores yielding 3 fine ounces of gold, 65 fine ounces of silver, and 1,600 pounds of copper, or an average value of precious metals of $7.53 per ton.

The crystalline rocks of the Appalachian gold belt cover the greater part of the northwestern third of South Carolina, but the producing gold and copper mines of the area are relatively few. Of the gold belts given by Nitze for North Carolina, as mentioned above, the last four cross over into South Carolina, where, however, Graton[b] distinguishes two belts fairly well defined and Sloan[c] indicates 13 mineral "zones." Of the three belts described by Becker[d] in the southern Appalachians the South Mountain belt may be considered as extending into Spartanburg County, S. C., and the Carolina belt to include the greater part of the gold mines of the State to the east of this. The rocks mainly containing the ore deposits are considered by Graton as pre-Cambrian[e] and by Becker[f] and Nitze and Hanna[g] as of Algonkian age. The ore deposits are of two general types—fissure veins of quartz, chiefly containing gold and pyrites and less

[a] Spencer, A. C., Magnetite deposits of the Cornwall type in Berks and Lebanon counties, Pa.: Bull. U. S. Geol. Survey No. 315, 1907, pp. 185–189; also, Magnetite deposits of the Cornwall type in Pennsylvania: Bull. U. S. Geol. Survey No. 359, 1908.

[b] Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: Bull. U. S. Geol. Survey No. 293, 1906, p. 110.

[c] Sloan, Earle, Catalogue of the mineral localities of South Carolina: South Carolina Geol. Survey, ser. 4, Bull. No. 2, 1908, pp. 409–412.

[d] Becker, G. F., op. cit., pp. 6–7.

[e] Graton, L. C., op. cit., p. 31.

[f] Becker, G. F., op. cit., p. 260.

[g] Nitze, H. B. C., and Hanna, G. B., op. cit., p. 44.

frequently lead and copper sulphides; and replacement deposits, chiefly yielding gold associated with pyrites. Intermediate deposits lie between these extreme types and really make them only end terms of a series.[a] The fissure-vein deposits are much the most numerous, being of the prevailing Appalachian type.

There was no production of gold, silver, copper, lead, or zinc reported from the Calais, Dorn, Douglas, or other mines of Abbeville County in 1908, and there was but a small placer output in Cherokee County. The Brewer mine, of Chesterfield County, was also idle during the year.

In Lancaster County the Blackmon and the Davis mines were also idle in 1908. The Haile mine, however, for several years past the largest producer of gold east of the Black Hills, continued its important output until August 10, 1908, when an explosion of boilers in the mill killed the superintendent, E. A. Thies, injured several others, and caused a temporary shut down.

The loss of Mr. Thies, not only to the Haile mine but to mining in the Eastern States as a whole, where problems are almost uniformly difficult and where successes of late years in mining and treating ores from below water level are relatively few, is very great. The name has been long and honorably connected with Southern mining and metallurgy, and since the retirement from active management of Adolph Thies—who improvised economical methods of mining large bodies of low-grade ore, originated the Thies chlorination process, and made the Haile mine pay—his son, the late Ernest Thies, has been in charge.

The Haile mine is now developed by a vertical shaft 200 feet deep and by levels, drifts, and great open cuts and the equipment for treatment of the ore includes a 60-stamp mill with Wilfley concentrators and a chlorination plant. There are several large ore bodies, of which the most important are the Beguelin, Bumalo, and Haile. These are described by Graton[b] as lens-shaped replacement bodies in altered porphyry tuff. Diabase dikes cut the ore bodies, as frequently elsewhere they cut the typical lenticular fissure veins of the Appalachians, but are not thought by Graton[c] to have enriched the ore. The present writer has already expressed the opinion that such dikes have no bearing on the genesis or relative richness of different portions of the ore deposits of the Franklin mine in Georgia. Sloan, however, apparently holds otherwise with respect to the Haile mine.[d] The gold of the Haile mine occurs both free, either originally or from the oxidation of pyrite, and in pyrite. The gangue is silicified schist. There are numerous recent references upon this important and interesting mine.[e]

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[a] Graton, L. C., op. cit., p. 61.
[b] Graton, L. C., op. cit., p. 80.
[c] Graton, L. C., op. cit., pp. 70–72, 86–87.
[d] Sloan, Earle, op. cit., pp. 64–66.
[e] Spilsbury, E. G., Gold mining in South Carolina: Trans. Am. Inst. Min. Eng., vol. 12, 1884, pp. 99–106.
Thies, A., and Mezger, A., The geology of the Haile mine, South Carolina: Trans. Am. Inst. Min. Eng., vol. 19, 1891, pp. 595–601.
Becker, G. F., op. cit., pp. 306–308.
Nitze, H. B. C., and Wilkens, H. A. J. (with Thies, A.), The present conditions of mining in the southern Appalachian States: Trans. Am Inst. Min. Eng., vol. 25, 1896, pp. 767–787, also discussion by A. Thies, H. B. C. Nitze, and William B. Phillips, pp. 1016–1027. Also, Gold mining in North Carolina and adjacent southern Appalachian regions: Bull. North Carolina Geol. Survey No. 10, 1897, pp. 125–143.
Nitze, H. B. C., The genesis of the gold ores in the central slate belt of the Carolinas: Eng. and Min. Jour., vol. 63, 1897, pp. 628–629.
Graton, L. C., op. cit., pp. 77–87.
Sloan, Earle, op. cit., pp. 59–74

In Pickens County there was no output reported for 1908, and in Spartanburg County there was but a small production of placer gold. In Union County the West mine was idle. A small quantity of gold was produced from surface work near Pacolet.

There was considerable development work in 1908 reported from the Darwin mine in York County; and there were a number of shipments of ore to West Norfolk in 1906 and 1907, but there was no output in 1908. There was no production from the Ferguson or Wilson mines, but the Ginemore Mining Company, the Cherokee Mining Company, and F. W. Aldrich reported production from shipments of ore from this county resulting from prospecting and development work.

TENNESSEE.

Mine production of gold, silver, copper, and zinc in Tennessee in 1907 and 1908.

Year.	Gold.		Silver.		Copper.		Zinc.		Total. value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity	Value.	
	Fine oz.		*Fine oz.*		*Pounds.*		*Pounds.*		
1907	185.04	$3,825	58,358	$38,516	18,893,115	$3,778,623	218,643	$12,900	$3,833,864
1908	178.94	3,699	57,696	30,579	19,459,501	2,568,654	688,149	32,343	2,635,275
Increase (+) or decrease (−).	−6.10	−126	−662	−7,937	+566,386	−1,209,969	+469,506	+19,443	−1,198,589

In 1908 the production of gold, silver, copper, and zinc in Tennessee was valued at $2,635,275. As compared with the corresponding figures for 1907, this shows a decrease in value of $1,198,589. The gold production was 178.94 fine ounces, valued at $3,699; the silver production, 57,696 fine ounces, valued at $30,579; the copper production, 19,459,501 pounds, valued at $2,568,654; and the spelter production, 688,149 pounds, valued at $32,343. The gold output, which has been very small in Tennessee, was slightly lower than in 1907. The production of silver was decreased by only 662 fine ounces in quantity, but by $7,937 in value, owing to the decreased market price of this metal. The copper output showed an increase of over 500,000 pounds in quantity, but, owing to the difference in price of copper in 1907 and 1908 the value of the output in the latter year showed a decrease of $1,209,969. The zinc output in 1908 was over three times as large as that of 1907 in quantity, but the lower price of the metal in 1908 reduced the value to but a little more than twice that of 1907.

The production of placer gold in 1908, all from Monroe County, was 29.61 fine ounces, and of gold from deep mines, all from the copper ores of Ducktown in Polk County, was 149.33 fine ounces. There was no silver reported from placer or zinc mines in 1908, but the output from copper ores was 57,696 fine ounces. Four deep mines produced 638,033 tons of ore, of which 618,806 tons were of copper ore and 19,227 tons were zinc ore. The copper ore yielded an average of 31.4 pounds of copper, and a value of $0.05 in precious metals per ton. The gold and silver is recovered from but a part of Ducktown ore, however, as some of the casting copper produced is shipped abroad unrefined. The zinc ores yielded no precious metals, but an average of 35.8 pounds of spelter per ton of crude ore mined.

Along the boundary line between Tennessee and North Carolina extend the Cambrian or pre-Cambrian rocks, including the gold and copper deposits of Monroe and Polk counties. Bordering these rocks on the northwest, and extending from Alabama to Canada are the Paleozoic rocks, including the Cambro-Ordovician Knox dolomite in which are found the lead-zinc deposits of eastern Tennessee and western Virginia. Some useful references recently published on the ore deposits and mining in Tennessee are given in the footnote.[a]

From Bradley and Claiborne counties there was no production of lead or zinc reported in 1908. In Claiborne County is the Straight Creek mine in a lead-zinc sulphide replacement ore body in brecciated Knox dolomite.[b] In Blount County, south of Knoxville, and in Bradley County, east of Chattanooga, galena has been found in a number of localities in the Knox dolomite. Watson considers the prospects encouraging, particularly at the Cedar Ridge mine.[c] In Jefferson County the Newmarket Zinc Company reported production in 1908. Their mines near Newmarket have produced considerable ore in the past. The deposits are of the breccia-replacement type, the ores being carbonates and silicates in weathered portions of the ore bodies and sphalerite in the unaltered limestone.[d] The mines are worked by open cuts and shafts, and the ores are dressed by washers, crushers, rolls, jigs, and tables. The mines were operated but four months in 1908. The Mossy Creek mines[e] in this county, where zinc ores were first discovered in Tennessee, are of the same type as those of Newmarket. These mines, and the Loy mine, near Newmarket, were idle in 1908. In Knox County the Mascot mine,[f] of the Roseberry Zinc Company, was also idle during the year, but the Kewanee Zinc Company, successor to the Holston Zinc Company, operated the mines near Mascot from July to the end of 1908, and reported an important production of zinc concentrates. In Monroe County the gravels of Coker Creek were worked to a slight extent by two companies and a small amount of placer gold was produced.

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[a] Brewer, William M., The Ducktown, Tenn., copper-mining district: Eng. and Min. Jour., vol. 59, 1895, p. 271. Also Mineral resources along the line of the East Tennessee, Virginia, and Georgia divisions of the Southern Railway: Eng. and Min. Jour., vol. 61, 1896, pp. 65–66.

Heinrich, Carl, The Ducktown ore deposits and the treatment of the Ducktown copper ores (Tenn.): Trans. Am. Inst. Min. Eng., vol. 25, 1896, pp. 173–245.

Blake, William P., Notes and recollections concerning the mineral resources of Northern Georgia and western North Carolina: Trans. Am. Inst. Min. Eng., vol. 25, 1896, pp. 796–811.

Kemp, J. F., Minerals of the copper mines at Ducktown, Tenn: Science, new ser., vol. 8, 1898, pp. 839–940. Also, The deposits of copper ores at Ducktown, Tenn.: Trans. Am. Inst. Min. Eng., vol. 31, 1902, pp. 244–265. Also, Ore deposits of the United States and Canada, 5th ed., New York, 1903, pp. 190–194.

McCallie, S. W., The Ducktown copper mining district: Eng. and Min. Jour., vol. 74, 1902, pp. 439–441.

Weed, W. H., Types of copper deposits in the southeastern United States; Trans. Am. Inst. Min. Eng., vol. 30, 1901, pp. 449–504. Also, Copper deposits of the Appalachian States; Bull. U. S. Geol. Survey No. 213, 1903, pp. 181–185. Also, The copper deposits of the eastern United States: Bull. U. S. Geol. Survey No. 260, 1905, pp. 211–216. Also, The copper mines of the United States in 1905: Bull. U. S. Geol. Survey No. 285, 1906, pp. 93–124. Also, The copper mines of the world, New York, 1907, pp. 348–351.

Ingalls, W. R., Production and properties of zinc, New York, 1902, pp. 197–203.

Keith, A., Recent zinc mining in East Tennessee: Bull. U. S. Geol. Survey No. 225, 1904, pp. 208–213.

Watson, T. L., Lead and zinc deposits of the Virginia-Tennessee region: Trans. Am. Inst. Min. Eng., vol. 36, 1906, pp. 681–737.

Clark, W. C., Zinc in eastern Tennessee: Mines and Minerals, vol. 27, 1907, p. 395. Also, The zinc belt of Claiborne and Union counties, Tenn.: Mines and Minerals, vol. 27, 1907, p. 567.

Higgins, E., Mining and smelting in the Ducktown district: Eng. and Min. Jour., vol. 86, 1908, pp. 1237–1241.

Channing, J. P., Copper smelting in Tennessee: Min. and Sci. Press, vol. 96, 1908, p. 97.

Gottsberger, B. B., Mines and works of the Tennessee Copper Company: Mining World, vol. 29, 1908, pp. 911–914.

[b] Watson, T. L., op. cit., pp. 725–730.

[c] Watson, T. L., op. cit., pp. 734–735.

[d] Watson, T. L., op. cit., p. 732.

[e] Keith, A., Morristown folio (No. 27), Geol. Atlas U. S., U. S. Geol. Survey, 1896, p. 5.

[f] Keith, A., Maynardsville folio (No. 75), Geol. Atlas U. S., U. S. Geol. Survey, 1901.

In Polk County the mines of the Ducktown district made their usual important copper output, with an incidental production of silver and gold. The Mary and East Tennessee mines of the Ducktown Sulphur, Copper, and Iron Company, and the Polk County, Burra Burra, and London mines of the Tennessee Copper Company were operated almost continuously throughout the year, and the two smelting plants were also actively operated. The vertical shafts of the Mary, the East Tennessee, and the Polk County mines are, respectively, 550, 700, and 385 feet deep; and the inclined shafts of the Burra Burra and the London mines are, respectively, 812 and 570 feet deep. The Ducktown Company plant includes a 500-ton smelter; and the Tennessee plant includes a rock-crushing plant at each mine and a 2,000-ton smelter containing 7 blast furnaces and 4 converter stands, in which the ore is pyritically smelted, and from which the Bessemer copper is exported to Europe. The new sulphuric acid plant of the Tennessee Copper Company, built in 1906–1907 to prevent escape of gases that were both injurious to the surrounding country and at the same time valuable for their acid content, was in full operation in 1908, and a large quantity of sulphuric acid was recovered as a by-product. The ore deposits at Ducktown, fully described by Heinrich, Weed, and Kemp, and more recently by Higgins and Gottsberger, in the references given, are fissure and replacement fillings in pre-Cambrian schists thought to be of sedimentary origin. The outcrops of gossan, formed to a depth of 60 to 75 feet by leaching processes forming secondary enrichment below, have been extensively worked for iron ore, and the greater part of the rich black copper ores just above the unaltered primary ore bodies have also been mined. The principal ore now worked is chalcopyrite disseminated through great masses of pyrrhotite. The ore is of low grade and can be successfully worked only by the highly developed methods of mining and metallurgy characterizing the practice now in force.

In Sullivan County the Fall Branch lead-zinc mine, just across the Sullivan-Washington County line from Fall Branch, reported no production in 1908, although there was considerable development work done and the construction of a 100-ton concentrating mill was nearly completed. A vertical shaft is now 180 feet deep. The deposit is of calamine and blende in a 5-foot vein in brecciated Knox dolomite near the fault contact with the overlying shale.[a]

VERMONT.

There was no production of copper, silver, or gold reported from Vermont in 1908. The output of copper in 1907 had been important and promised increase, but the industrial depression and local difficulties shattered all hopes for 1908.

There has been considerable fruitless expenditure of money in attempts to mine gold, silver, and lead in Vermont, and the instances in which mining of these metals has yielded returns at all are only isolated.

In Bennington County, near Readsboro, there have been reported gold finds, but the results were wholly unprofitable.[b] In Franklin County, near Richford, on the Canadian border, indications of copper

[a] Keith, A., Greeneville folio (No. 118), Geol. Atlas U. S., U. S. Geol. Survey, 1905, p. 8.
[b] Smith, G. O., Quartz veins in Maine and Vermont: Bull. U. S. Geol. Survey No. 225, 1904, p. 85.

ores are said by Hager [a] to be quite abundant. The Acton (Canada) copper belt seems here to cross the line into Vermont and to be traced as far south as Waterbury in Washington County. In Lamoille County, near Morristown, an unimportant lead-zinc deposit was known in the "talcose slate" of Hager,[b] but it appears to have been but little developed.

In Orange County are the three well-known copper districts of the State: Corinth, Copperfield, and South Strafford. The ore bodies are described by Weed[c] as overlapping lenses lying in the foliation of mica schists. According to Smyth and Smith [d] they are replacement deposits as well as fissure fillings, and so fall into a class well recognized in Appalachian geology. The ore is chalcopyrite disseminated through pyrrhotite, and the deposits are in general of the Ducktown type. The bodies are massive in the wider parts of the veins, and large quantities of ore have been extracted since mining first began for the making of copperas at the Elizabeth mine in 1793. The ores are of low grade and require the most skillful mining and treatment, as at Ducktown, to make them pay. The Elizabeth mine, near South Strafford now owned by the Vermont Copper Company, the oldest mine in the State and an important producer in the past, has been under recent renewed development. This is the most southern mine in the copper belt. A new 300-ton blast furnace was built in 1907 and 1908 and also a dam at Sharon on White River to furnish power for mine and smelter. During 1908 a disaster to the dam postponed production. The adit to the mine is 1,350 feet long. The old Union mine, the most northern of the copper belt, near Corinth, owned by the Corinth Copper Company, and idle in 1908, was also a producer for over twenty years, though less important in the matter of output than the Elizabeth or Ely mines. The Pike Hill mines, of the Pike Hill Mining Company, were not operated in 1908. These are developed by an adit 570 feet long, at the end of which is an incline 330 feet deep. The ore-dressing plant is a 30-ton magnetic concentrating mill. The Orange mine, near Westmoreland, developed by a 107-foot incline and 65 feet of work on the 100-foot level was idle in 1908; but the Manion prospect just north of this property was opened in 1908, and a good showing of chalcopyrite was reported. The famous old Ely (Copperfield or Vershire) mine was also idle in 1908. This is the deepest mine in Vermont and has produced considerable copper. It is now owned by the George Westinghouse interests. The equipment has been extensive and varied, including both concentrating and smelting plants, and at times the mine has paid well.

In Rutland County there have been reported deposits of lead at Chittenden and of silver at Wallingford, but Hager points out that the latter is purely mythical and the former of little value.[e] In Windsor County, likewise, there are unimportant occurrences of lead and zinc sulphides at Norwich, Plymouth, and Bridgewater, and of gold at Springfield, Plymouth, and Bridgewater. The last two regions have been recently described by Smith,[f] and appear to

[a] Hager, A. D., Economical geology of Vermont: Rept. on Geology of Vermont, vol. 2, Claremont, 1861, p. 850.
[b] Hager, A. D., op. cit., p. 839.
[c] Weed, W. H., Notes on the copper mines of Vermont: Bull. U. S. Geol. Survey No. 225, pp. 190–199.
[d] Smyth, H. L., and Smith, P. S., The copper deposits of Orange County, Vt.: Eng. and Min. Jour., vol. 77, 1904, pp. 677–678.
[e] Hager, A. D., op. cit., pp. 841–842.
[f] Smith, G. O., op. cit., pp. 86–88.

be of little promise in a practical way. Deep mining for gold, lead, or zinc has shown chiefly negative results in Vermont, and placer mining, though yielding small outputs of gold at times, has never given large returns.

VIRGINIA.

Mine production of gold, silver, copper, lead, and zinc in Virginia in 1907 and 1908.

Year.	Gold.		Silver.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ozs.		*Fine ozs.*		*Pounds.*	
1907	400.93	$8,288	221	$146	58,880	$11,776
1908	118.57	2,451	236	125	24,775	3,270
Increase (+) or decrease (−)	−282.36	−5,837	+15	−21	−34,105	−8,506

Year.	Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
1907					$20,210
1908	76,190	$3,200	1,410,961	$66,315	75,361
Increase (+) or decrease (−)	+76,190	+3,200	+1,410,961	+66,315	+55,151

In 1908 the value of the production of gold, silver, copper, lead, and zinc in Virginia was $75,361, an increase of $55,151 over that of 1907. The production of gold was 118.57 fine ounces, valued at $2,451, a decrease of 282.36 fine ounces in quantity and of $5,837 in value, as compared with the corresponding figures for 1907. The production of silver was 236 fine ounces, valued at $125, an increase in quantity of 15 fine ounces, but a decrease in value of $21; and the production of copper was 24,775 pounds, valued at $3,270, a decrease of 34,105 pounds in quantity and of $8,506 in value. There was no output of zinc reported from the mines of this State in 1907, and the figures for lead were combined with those of New Hampshire in the report for 1907, but in 1908 there was a production of 76,190 pounds of lead, valued at $3,200, and of 1,410,961 pounds of spelter, valued at $66,315. There were 4 placers and 4 deep mines producing in 1908, and from the deep mines were reported 12,877 tons of ore, of which 230 tons were of siliceous gold ore yielding precious metal with an average value of $7.135 per ton, and 1,896 tons were of copper ores yielding $0.05 in precious metals and 12.4 pounds of copper per ton. Of lead ores, 800 tons yielded gold and silver valued at $0.28 and 95.2 pounds of lead per ton.

The most convenient general geographic division of Virginia deposits is probably the physiographic division of Watson. From east to west these may be called the Coastal Plain, Piedmont, Blue Ridge, Great Valley, and Alleghany regions.[a] Of these the first includes no important deposits. In the Piedmont Plateau is the Virginia mineral belt, extending from Montgomery County in Maryland, across the Potomac and through Fauquier, Stafford, Culpeper, Orange,

[a] Watson, T. L., Mineral resources of Virginia, Virginia Jamestown Exposition Commission, 1907, pp. 1–12.

Spottsylvania, Louisa, Fluvanna, Goochland, and Buckingham counties, and continued through Appomattox, Prince Edward, Charlotte, and Halifax counties into North Carolina. This belt is capable of subdivision; but in its broad outlines it includes the principal known gold deposits, the copper deposits of the Virgilina district in Halifax County and of Albemarle, Buckingham, and Charlotte counties, the zinc ores of Albemarle, and the principal pyrite deposits of Virginia, including those of Louisa and Prince William counties. The Blue Ridge region includes the copper deposits of that name and also the gossan pyrrhotite lead of Floyd, Carroll, and Grayson counties. The Great Valley region includes, principally in Smyth and Wythe counties, all the lead-zinc deposits of Virginia, except those in Albemarle County above mentioned. In addition to these there are scattered gold deposits in various counties and copper occurences in Triassic beds in Culpeper and Loudoun counties, all in the Piedmont region and of little importance so far as developed.

The rocks of the Piedmont area, which extends from the "fall line" (separating it on the east from the Coastal Plain) to the Blue Ridge Mountains on the west, are crystalline and considered chiefly of pre-Cambrian age, although some of them may be as late as Ordovician.[a] They are overlain by several patches of the Triassic sediments and in general strike northeasterly and dip southeasterly, as is characteristic of the greater portion of the rocks of the Appalachian mineral belt. The Blue Ridge region exposes rocks also chiefly pre-Cambrian, including basic igneous metamorphic types, but also including Cambrian sandstones on the west. The Great Valley is of Paleozoic sediments, including the Cambro-Ordovician Knox dolomite, which is the home of the lead and zinc ores. The ore deposits considered here and occurring in the above areas, are of the lenticular-fissure type, in part showing replacement, with the exception of the lead-zinc deposits of the Great Valley, in southwestern Virginia, which are a northeastward continuation of the Tennessee lead-zinc belt and are in brecciated Knox dolomite, showing replacement of the calcareous rock by ore.

Some fairly accessible recent references on the mines producing gold, silver, copper, lead, and zinc in Virginia [b] are given in the footnote.

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[a] Watson, T. L., op. cit., p. 7.

[b] Case, William H., The Bertha zinc mines at Bertha, Va.; Eng. and Min. Jour., vol. 66, 1898, pp. 292–294; also, The Bertha zinc mines at Bertha, Va.: Trans. Am. Inst. Min. Eng., vol. 32, 1901, pp. 511–536.

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Watson, T. L., Copper-bearing rocks of the Virgilina copper district, Virginia and North Carolina: Bull. Geol. Soc. America, vol. 13, 1902, pp. 353–376; also, Lead and zinc deposits of Virginia: Bull. Virginia Geol. Survey No. 1, 1905; also, The copper deposits of Virginia: Eng. and Min. Jour., vol. 82, 1906, pp. 824–825; also, Lead and zinc deposits of the Virginia-Tennessee region: Trans. Am. Inst. Min. Eng., vol. 36, pp. 681–737; also, Mineral resources of Virginia; The Virginia Jamestown Exposition Commission, Lynchburg, 1907.

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Weed, W. H., and Watson, T. L., The Virginia copper deposits: Econ. Geology, vol. I, 1906, pp. 309–330.

Phalen, W. C., Copper deposits near Luray, Va.: Bull. U. S. Geol. Survey No. 285, 1906, pp. 140–143.

Judd, E. K., The Virgilina copper belt; Eng. and Min. Jour., vol. 82, 1906, pp. 1005–1008.

In Albemarle County the Faber lead-zinc mine of the Albemarle Zinc and Lead Company was not operated in 1908. This is the only mine of lead and zinc in Virginia not in the Cambro-Ordovician limestones of the Great Valley. The deposit is a lens-shaped fissure filling in crystalline schists, probably pre-Cambrian, and is characterized by a fluorite-quartz gangue carrying galena and sphalerite. The mine is developed by 3 shafts and is equipped with an 80-ton concentrating mill. Near Stony Point in this county is a gossan deposit thought by Watson[a] to lie above chalcopyrite. The vein is 5 to 6 feet wide in sericite schists. In Buckingham County are a number of gold and copper mines near Arvonia, Dillwyn, Johnston, and New Canton, from which considerable gold was reported many years ago; but they have not produced in recent years. Through Carroll County extends the "great gossan lead," a wide, well-defined vein of pyrrhotite, carrying disseminated chalcopyrite, and lying in sericite chists. The deposits were first mined for the limonite capping and afterwards produced a considerable quantity of copper from the rich secondary sulphides. The present problem is mainly to work the low-grade primary sulphides at a profit. The principal mines are the Betty Baker, Cranberry, Gardner and Goad, Great Outburst, Vaughn, and Wild Cat, none of which reported production in 1908. Near Keysville, in Charlotte County, and north of Virgilina, in Halifax County, are some copper and gold deposits but little developed that may prove an extension of the Virgilina gold-copper belt. The copper ores are said by Watson[b] to be identical with those of Halifax County. In Culpeper County are some copper deposits near Stevensburg, of little apparent importance, in the Triassic sedimentary rocks, and several prospects from which there was a small production of placer gold in 1908. In Fauquier County, near Morrisville, are a number of old gold mines, among them the Franklin, Kelly, Kirk, and Liepold mines. The latter has been prospected by the Virginia Mining and Development Company by 2 shallow shafts, and has been equipped with a 10-stamp mill, but operations have been tied up by litigation. In Floyd County there is some placer mining for gold, and there was a small production from the Brush Creek mine in 1908. In this county also is the Toncray mine, of the New York and Virginia Copper Company, on an extension of the "great gossan lead." The mine is now developed by a 225-foot vertical shaft and several adits. A 75-ton smelter has been built. There was no production in 1908, but considerable development and construction work were reported. The ores, ore body, and geological relations are as given above for the gossan lead. In Fluvanna and Goochland counties are a number of old mines, from some of which, as the Tellurium, an important production of gold was reported many years ago. This mine, partly in each county, was discovered in 1832 and worked continuously for twenty-five years, and again as late as 1886.[c] The Bowles, Fisher, Moss, and Busby mines are all on the strike of the Tellurium veins, and also on the border line between the two counties. The Page and Hughes mines are in Fluvanna County, and the Belzora, Marks, Collins, Eades, Big Bird, and other mines in Goochland. The ores are oxidized and milling-gold ores to a depth of over 100 feet. Beyond this

[a] Watson, T. L., Mineral Resources of Virginia, pp. 502–503.
[b] Watson, T. L., idem., p. 500.
[c] Watson, T. L., idem., p. 559.

they are sulphides and have been but little worked. The containing rocks are crystalline schists. In Goochland County there was a small production of gold in 1908. In Franklin County, according to Watson,[a] gold is found in quartz veins in micaceous schists between Pig River and Rocky Mount. In Grayson County gold has been found in small quantities, and here the gossan lead is also traced. In Greene County, in the Blue Ridge, are the Hightop and Sims copper prospects, in which native copper, cuprite, and malachite, and bornite and chalcopyrite, have been found. These deposits are of the "Catoctin type" of Weed.[b]

In Halifax County are the important copper deposits of Virgilina and the Gold Banks mine. The Virgilina belt extends across the state line into Granville and Person counties of North Carolina, as already described, and includes gold and copper bearing lenticular quartz veins in crystalline schists. The copper mines have been described by Weed, Watson, and others in references already given. The copper deposits lie on a western ridge rising slightly above the Piedmont Plateau, and the Gold Banks mine, a recent discovery and the only gold mine of the district, lies on an eastern parallel ridge. This mine is developed by a vertical shaft 200 feet deep and by several hundred feet of levels, and is equipped with a 20-stamp mill. The Gold Banks mine was a producer of gold in 1908. The only copper mine producing was the Seaboard, whose 100-ton concentrating mill worked over ores mined in previous years. This mine is developed by 600 feet of shafts and 400 feet of levels. The Pontiac, Tallyhill, Chappel, and High Hill mines were not producers in 1908. The bornite and chalcocite ores of Virgilina seem capable of clean concentration from the siliceous gangue, as demonstrated at the new Seaboard mill; but they are generally of low grade and do not seem to be workable at a profit with present low prices for copper.

In Louisa County are a number of gold quartz veins, some of them associated with the well-known pyrite deposits. On North Contrary Creek is the Tinder Flats placer deposit, once very productive, and near Mineral City is the Fisher Lode, on which were opened the Harris, Slate Hill, Louisa, Luce, and Warren Hill mines.[c]

The ore deposits of greatest importance in this county are the lenticular fissure pyrite bodies in schists near Mineral City. The Arminius, Smith, and Sulphur mines are the most important, and the first and third of these are steady producers of pyrite and of copper obtained as a by-product. The mines have been recently well described by Nason and Watson,[d] and briefly by Phalen.[e] The ore is fine to coarse granular pyrites, with small amounts of blende, chalcopyrite, galena, pyrrhotite, and magnetite, and with calcite-quartz gangue. Hornblende and garnet also occur. Gold quartz veins are sometimes found in adjacent walls. Copper is recovered from mine water in cement form, and chalcopyrite is separated out from crude ore from time to time by hand sorting when sufficiently plentiful in the veins. The chief production is of pyrite for use in making sulphuric acid. The Sulphur mine is developed by 3 vertical shafts from 500 to 700 feet deep and by

[a] Watson, T. L., Mineral Resources of Virginia, p. 551.
[b] Weed, W. H., Types of copper deposits in the southern United States: Op. cit., p. 503.
[c] Nitze, H. B. C., and Wilkens, H. A. J., Bull. North Carolina Geol. Survey No. 10, p. 74. Watson, T. L., Mineral Resources of Virginia, pp. 558–559.
[d] Nason, F. L., op. cit., pp. 414–416. Watson, T. L., Mineral resources of Virginia, pp. 190–202.
[e] Phalen, W. C., Sulphur and pyrite; Mineral resources U. S. for 1908, U. S. Geol. Survey, 1909.

levels at 50-foot intervals. The Arminius mine is developed by an inclined shaft now 980 feet deep, with levels at intervals of from 60 to 100 feet; the concentrating plant includes crushers, rolls, and jigs, and has a daily capacity of 200 tons.

In Orange County, near the Rapidan, are the old Vaucluse, Chicago Virginia, Randolph, Orange Grove, Greenwood, Melville, and Grasty mines, operated by a number of companies in the last century and producing considerable gold from the oxidized zone. In Page County near Ida and Dark Hollow are several mines in copper deposits of the "Catoctin type" of the Blue Ridge, previously mentioned. The Blue Ridge Copper Company and the Virginia Consolidated Copper Company have done considerable development, but their mines were closed during 1908. In Rappahannock and Warren counties are other copper deposits of this type, and in Prince Edward County are some small gold prospects. In Prince William County, near Dumfries, is the Cabin Branch mine, of the Cabin Branch Mining Company, an important producer of pyrite, with incidental production of chalcopyrite. The ores and geologic relations classify this deposit with the pyrite ore bodies of Louisa County described above. Chalcopyrite is obtained in greater quantity, however, and in parts of the vein pyrite and chalcopyrite lenses seem to overlap, rendering hand sorting of copper ore in the mine a simple operation. A small smelter has been erected on the Potomac near Dumfries in which the copper sulphides are smelted to a 40 per cent matte for shipment. This mine is an important producer. The shaft is now over 1,000 feet deep.

In Pulaski, Roanoke, Russell, Scott, Smyth, Tazewell, and Wythe counties, of southwestern Virginia (in the Great Valley), are the well-known lead-zinc deposits in the Cambro-Ordovician Knox dolomite. The primary ores, chiefly blende and galena, are sometimes associated with small amounts of pyrite and chalcopyrite, and the alteration products are calamine, smithsonite, and cerussite. The ores are found with dolomite and calcite and occasionally with barite, fluorite, and quartz; and the deposits are of the disseminated replacement breccia type of Watson.[a] The principal zinc producers are the Bertha and Austinville mines of Wythe County, and the chief producer of lead is the Sugar mine of the Chamberlain Mineral Company near Sugar Grove in Smyth County. The Austinville mines, worked for over one hundred and fifty years, mainly in open cuts, and now operated by the Bertha Mineral Company, yielded an important output of spelter in 1908 from ore and old tailings re-treated. There is a vertical shaft 435 feet deep and an adit 1,200 feet long connecting with the 235-foot level. The plant includes a 100-ton concentrating mill. The Sugar mine, of Smyth County, produced lead in 1908 from concentrates made in the 100-ton mill and shipped to Carnegie, Pa. The mine is opened by a 220-foot vertical shaft and further developed by 450 feet of levels. The year was spent chiefly in development work and in prospecting for additional ore.

In Stafford County is the pyrite mine near Garrisonville of the Austin Run Mining Company, probably on the southwestern strike of the Cabin Branch mine in Prince William County and of the

[a] Watson, T. L., op. cit., p. 527; also, Lead and zinc deposits of Virginia, op. cit., p. 50.

same type. There was no production from this mine, nor from small placer mines in this county which produced a little gold in 1907. In this county also are the old Eagle, Lee, Monroe, Rattlesnake, and Rappahannock gold mines, the last of which was extensively worked many years ago. In Spottsylvania County are also a number of gold mines, and there was a small production of gold from this county during the year. The Whitehall mine yielded rich pockets of gold, in early mining, and is reported to have had a considerable production at that time.

QUICKSILVER.

By H. D. McCaskey.

CONDITION OF INDUSTRY.

The general condition of the quicksilver industry has not been satisfactory during the last few years. Domestic demand for the metal has not been great, owing to changing metallurgical processes, and the profit in exporting quicksilver to the Orient has been cut by competition from foreign countries. There will, however, remain indefinitely a domestic demand of considerable importance, and it will be noted in the analysis of import and export tables in this report that the quicksilver brought into the United States to meet this demand both in 1907 and in 1908 was greatly in excess of the imports of previous years; that, although there were no exports to China in 1908, the exports to Mexico were but little less than those of 1907; and that the quicksilver sent to Canada in 1908 was more than twice the quantity and value of that sent in 1907. Prices for the metal greatly improved in 1908, and on the whole the situation was somewhat better than in 1907.

PRODUCTION.

The production of quicksilver in the United States in 1908, as obtained from returns made to the Survey from every mine producing during the year, was 19,752 flasks of 75 pounds each, and was valued at $824,146. As compared with the production of 1907, this was a decrease of 1,815 flasks in quantity and of $4,785 in value. An annual decrease of the production of quicksilver is noted for the last five years, and the output of 1908 was the smallest recorded since 1860. The production of quicksilver in 1908 was, as usual, chiefly from California, although Arizona and Oregon, which furnished no output in 1907, added somewhat to the production of 1908. There was no quicksilver reported from Utah during the year. Slightly decreased quantity was reported from California, but owing to improved prices the value of the production increased over that of 1908. In Texas both quantity and value of production decreased.

The following table shows the production, in flasks of 75 pounds each, and the values for the United States in the years 1907 and 1908:

Production of quicksilver in the United States in 1907 and 1908, in flasks of 75 pounds.

State.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Arizona and Oregon			386	$17,170
California	17,431	$662,544	16,984	684,716
Texas	3,686	148,387	2,382	122,260
Utah	450	18,000		
	21,567	828,931	19,752	824,146

RESOURCES AND DEVELOPMENT.

CALIFORNIA.

During 1908 California produced 16,984 flasks of quicksilver, valued at $684,716. This was a decrease of 447 flasks in quantity, but owing to the higher prices for the metal in 1908, there was an increase in value of the output. Although there have been decreases in the production of California for the last three years, they have been smaller each year. In 1908 California furnished 86 per cent of the total production of the United States, an increase of 5.2 per cent over the proportion of the production of 1907 and of 8.6 per cent over that of 1906.

Below is a table showing the production of California, by years, since 1850:

Total production of quicksilver in California, 1850–1908, in flasks.[a]

1850	7,723	1871	31,686	1892	27,993
1851	27,779	1872	31,621	1893	30,164
1852	20,000	1873	27,642	1894	30,416
1853	22,284	1874	27,756	1895	36,067
1854	30,004	1875	50,250	1896	30,765
1855	33,000	1876	72,716	1897	26,691
1856	30,000	1877	79,395	1898	31,092
1857	28,204	1878	63,880	1899	29,454
1858	31,000	1879	73,684	1900	26,317
1859	13,000	1880	59,926	1901	26,720
1860	10,000	1881	60,851	1902	28,972
1861	35,000	1882	52,732	1903	30,526
1862	42,000	1883	46,725	1904	29,217
1863	40,531	1884	31,913	1905	24,635
1864	47,489	1885	32,073	1906	20,310
1865	53,000	1886	29,981	1907	17,431
1866	46,550	1887	33,760	1908	16,984
1867	47,000	1888	33,250		
1868	47,728	1889	26,464		2,052,069
1869	33,811	1890	22,926		
1870	30,077	1891	22,904		

The condition of the industry in California in 1908 was such as to cause the producers considerable concern. There was marked improvement in price, but the minimum demand of the last few years continued to prevail, and the market in the Orient was not attractive. Added to this was the fact that the chief producers in the State were working in low-grade ore, and the greatest metallurgical skill and business economy were required that the mines might pay at all. In view of the fact that the market conditions are responsible for the small production of recent years and that the mines can probably considerably increase their output if encouraged to do so, the problem seems largely one of increasing the market, possibly by researches of industrial chemists into the field of new uses for quicksilver.

[a] 76½ pounds net; 75 pounds net since June 1, 1904.

The production of quicksilver in California for 1907 and 1908 is shown by counties in the following table:

Production of quicksilver in California, by counties, during 1907 and 1908, in flasks of 75 pounds.

County.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Colusa	11	$628	39	$1,700
Lake	657	24,000	1,103	46,166
Napa	2,600	96,406	2,420	96,800
San Benito	7,685	284,395	9,610	384,420
San Luis Obispo	2,476	98,210	465	20,730
Santa Clara	2,518	94,205	2,431	97,240
Solano	670	30.000	[a] 465	20,120
Sonoma	716	30,600	372	14,380
Trinity	98	4,100	79	3,160
Total	17,431	662,544	16,984	684,716

[a] Solano and Fresno combined for 1908.

From this table it will be noted that Colusa, Lake, and San Benito counties increased their output in 1908 over that of 1907, but that all the other producing counties of the State showed decreased yield. For several years the most important producing county in the State has been San Benito. Santa Clara and Napa counties followed considerably behind with almost equal production in 1908, and next in rank was Lake County. The three most important producing mines in 1908 were the New Idria of San Benito County, the Napa Consolidated of Napa County, and the New Almaden of Santa Clara County. Following these were the Helen and Great Western mines of Lake County, the St. John of Solano County, the Oceanic of San Luis Obispo County, the Socrates of Sonoma County, and the Guadalupe of Santa Clara County. Nine other mines also produced during the year.

Colusa County.—In Colusa County the Elgin and Baumeister mines of the New Elgin Quicksilver Mining Company, at Sulphur Creek, yielded a small production in 1908. The ore was concentrated on Gilpin County bumping tables, after which it was pan roasted in fire-brick retorts with the use of superheated steam, instead of lime, to take up the excess of sulphur. A large flow of hot alkaline water in the mine has stopped development work, and as a long drainage tunnel would seem to afford the only relief from this invasion, operations have been suspended for the time. The Manzanita mine, of the same district, yielded a small output in 1908 from concentrates retorted in a 30-ton furnace. The Wide Awake mine, also at Sulphur Creek, equipped with a 35-ton Scott fine-ore furnace with 18 iron condensers, has not been operated during the last five years.

Fresno County.—In Fresno County the Mercy mines, near Llamada, produced a small quantity of quicksilver treated in an experimental rotary furnace. The ore is cinnabar associated with quartz, and is reported by J. Nonish [a] to lie between altered sandstones, the croppings being traceable for a mile. The Providence mine was idle in 1908.

[a] Nonish, J., letter to the writer, December 25, 1908.

Lake County.—In Lake County the Big Injun mine, of the New Phoenix Mining Company, was idle, and the Baker mine has not been operated for several years. The Shamrock and the Franklin mines were not operated, and though a small amount of ore was taken from the Wall Street mine it was not reduced during the year. The Helen mine near by, in Dry Creek basin, was a producer in 1908, the ore being treated in a 50-ton Scott furnace. On the Chicago mine assessment work only was done during the year, and work on the Cinnabar King was confined to prospecting. The Great Western mine, which was opened in 1873 and had produced since 1874, continued its output in 1908. This property is equipped with a 40-ton Litchfield furnace.

Mendocino County.—In Mendocino County the Occident prospect was not worked during the year.

Napa County.—In Napa County the Corona mine was not operated in 1908. The Knoxville mine produced quicksilver from retorts and the 60-ton Scott and 20-ton Livermore furnaces with which the plant is equipped. Important development of new ore bodies was reported for the year. The Manhattan mine, equipped with one retort, one 24-ton fine-ore furnace, and one 20-ton coarse-ore furnace, was not operated, owing to the state of the quicksilver market during the year. The Oat Hill mine of the Napa Consolidated Quicksilver Mining Company, at Oat Hill, yielded a considerable production in 1908. This is one of the most important mines in the State and has produced for many years. The plant includes two 60-ton fine-ore furnaces, one of which was idle in 1908. The Philadelphia, Twin Peaks, Bella Union, Blue Peak, and La Joya mines were also idle during the year.

San Benito County.—In San Benito County the Bradford mine, which is equipped with a 6-ton Scott furnace, was idle in 1908, as were the Cerro Bonito, Providence, and Aurora mines, and the mines of the Stayton Mining Company. The Florence Mac mine produced some ore during development. The Ramirez or old Picachos mine made a small production.

THE NEW IDRIA MINES.

The well-known New Idria mine, in the southeastern part of San Benito County, remained in 1908 the chief producer of quicksilver in the United States. Discoveries of cinnabar were made here in 1853, and there has been production almost continuously since. The deposits outcrop conspicuously on the northern slopes of the high peaks of New Idria in the southern portion of the Diablo Mountain Range. The ore bodies are in the metamorphic rocks of the Lower Cretaceous, comprising serpentine, altered sandstones, and shales, and lie just south of the contacts with the unaltered sediments of the Chico formation (Upper Cretaceous), including soft, yellow sandstones, but also conglomerates, shales, and limestone. The sandstones frequently contain concretions and stand out in sharp relief as pinnacled ridges and bold bluffs. The limestone forms rounded slopes covered with soil and vegetation, and exposures are few. In the valleys farther north lie the Tejon formation (Eocene) and later sediments, deeply incised and showing terraces of three or more periods of uplift. The metamorphic rocks are much twisted, crushed, and fissured, and in part silicified; and postmineral fissures are suggested by faults observed in the workings, one of which, as noted

by Becker,[a] may have cut off the old New Hope ore body. The ore bodies mentioned by Becker[b] are the Elvan Streak, the New Hope, the Stockworks, and the Bell Tunnel. The Stockworks form a crescent-shaped fissure filling of breccia, cinnabar, and pyrite, and are now furnishing the principal supply of ore. The ore body seems to extend from near the surface to the 1,060-foot level opened up by a new tunnel entering the mountain on the northwest slope of the spur just above the furnaces, and driven 3,125 feet S. 31° W., meeting a winze from the No. 7 level at a point about 300 feet northwest of the face of the old Bell Tunnel. The so-called "hanging wall" of this great deposit is the "clay wall" of Becker[c] as pointed out by Forstner.[d] The so-called "foot wall" is a shale overlying sandstones and with a dip to the south on the 1,060-foot level apparently less steep than that of the clay seam. These facts, and such observations as were made, indicate the value of Becker's suggestions that the "clay wall" is not the true hanging wall of the main ore bodies, but the attrition product of postmineral faulting.[e] These "walls" cut across the bedding of the country rocks which dip northerly at gentle angles in the Chico formation and more steeply in the metamorphic rocks. The ore is irregularly found in "stocks" below the "clay wall." This "wall" overlying the New Idria ore body is a soft, heavy, black clay, or shale, in places highly twisted and showing shining "fish-scale" surfaces.

The gangue is silicified and brecciated metamorphosed sandstone and shale, usually dark, and is often chertlike and very hard. Deposition of cinnabar and accompanying pyrite seems to have been made in this crushed material after a first fissuring; and postmineral fissuring may have followed along the same general plane, the ore occurring mainly along surfaces and in cracks and crevices of the breccia. Impregnation has taken place more with pyrite than with the cinnabar. Both of these sulphides follow joint cracks into the adjoining foot wall. The ore is very irregularly distributed between the "walls" and is often difficult to trace, as chambers are stoped out. The tendency seems for the ore bodies to lie in shoots down the dip. A considerable amount of waste is necessarily handled, but as sorting is done in the mine much of this is used as filling. The two metallic minerals of the ore, cinnabar and pyrite, vary in relative quantity. The New Idria miners say "the cinnabar goes out as the pyrite comes in." The rocks underlying the ore deposit are chiefly sandstones, little indurated. As one enters the new tunnel on the 1,060-foot level the Chico sediments, mostly sandstones, are at first found little disturbed, but as the contact with the metamorphic rocks is neared they are seen to be somewhat more disturbed. The metamorphic rocks show frequent local and sharp disturbances from folding and faulting, particularly near the ore body. In the driving of this tunnel much natural gas was encountered in the permeable sandstones, and as the work in the tunnel was highly dangerous it was necessary for a time to

[a] Becker, George F., Geology of the quicksilver deposits of the Pacific slope: Mon. U. S. Geol. Survey, vol. 13, 1888, p. 304.
[b] Becker, George F., op. cit., 303.
[c] Becker, George F., op. cit., p. 302.
[d] Forstner, Wm., The quicksilver resources of California: Bull. California State Min. Bureau, No. 27, 1903, p. 140.
[e] Becker, George F., op. cit., pp. 304-306.

explode the accumulated gas daily by lights attached to long poles. The tunnel was completed without loss of life, however, and gas now coming into it is taken care of by an excellent ventilation system. The drifts in ore in the main deposits or Stockworks form a crescent curve in horizontal section, as already stated, the chord of the arc striking a little north of west. Croppings at the surface overlying these bodies stand out in bold outline on the mountain peak and strike in the same direction. It is planned to work out these remaining croppings and ore in the bodies below to the third level by great open cuts.

In addition to the Stockworks deposits are the old Bell tunnel and the New Hope ore bodies with northwesterly strike, which have not recently been worked, and the Elvan streak, a strong, clean-cut fissure filling of soft, wet, white clay and quartz from 2 to 3 feet wide, striking nearly north, and encountered in the workings through all the levels from the uppermost to the lowest. Ore is found in this vein and in the rock of both walls, and some production is regularly made from this source.

The mine is developed by 3 principal adits or tunnels known as the old Bell tunnel, the No. 7 tunnel, and the new No. 10 tunnel on the 1,060-foot level, as well as by several miles of levels, incline shafts, winzes, upraises, and stopes. The Bell tunnel opened up the ore body of that name, which has furnished large quantities of good ore. This tunnel is not now accessible, but the old ore bodies will be reached by an eastward drift from the face of the new tunnel. The principal workings are in the irregular bodies of the Stockworks, where large open spaces are now supported by square-set timbering. The old upper adits are at present used only for the tramming of waste rock not used in filling. The old incline shaft and a complete system of chutes are now in use for sending all ore, from the highest to the lowest levels where mining is done, down to the 1,060-foot level, where it is taken out by mule trains of four cars each to the bins just above the furnace. The system of transporting the ore, the cheap drainage of the workings by the new tunnel, the simple yet effective ventilation, largely by the "natural" system, are prominent economic features of mining these New Idria ores and contribute largely to the fact that the mine has paid dividends for many years. The old timbering in some of the upper workings has stood fairly well, and the timbering of more recent years has given excellent service and is in good condition, partly owing to the protective coating of whitewash used. The mine is dry, and timber lasts for many years.

The early surface and upper workings of the New Idria mine were productive of richer ore than the average ore mined in larger quantities at the present time. As in other quicksilver mines in California, there has been a decrease in tenor of the ore in depth, but the rule is not without many local exceptions. The records of furnace practice would indicate that the average ore now mined is of low grade—that is, that it yields in the furnace less than 1 per cent of metal. Owing to the large quantities of it available and mined and treated daily, however, ore yielding even one-half of 1 per cent can be worked at a profit by present practice.

The ore of the New Idria mine is treated in 3 furnaces at the mine. One of these is a Huttner-Scott tile twin furnace for fine ores, and the other two are Newcomb furnaces for coarse ores, designed by the

manager of the mine. The rather high content of iron pyrite in the New Idria ores greatly assists in furnace work and largely decreases fuel costs. In the Newcomb furnace the charge is not only heated on three sides, but it is rapidly spread out on coming into the fire chambers and thus receives at once the highest heat of the furnace.[a] Below the fire chambers there is sufficient depth for the ore to yield the last of its mercury vapors in cooling off before being drawn. The theoretical capacity of each coarse-ore furnace is 88 tons and of the fine-ore furnaces 60 tons per twenty-four hours. The ore space of the Newcomb furnace is 2,400 cubic feet, hence the ore remains but little more than twenty-four hours in the furnace. Fines can not well be treated in the tile furnace unless dry, and therefore wet fines are charged with coarse ore, and this tends to reduce the capacity of the Newcomb furnaces to about 80 tons each per twenty-four hours. Accumulated soot from furnaces, condensers, and flues is mixed with wood ashes on steam plates and worked with a hoe, and from this soot metallic mercury is readily separated. The dried soot is then burned to ash in retorts, yielding additional quicksilver. In the early New Idria condensers some of the brick used was so porous and absorbed so much metal that it has been saved as the furnaces were rebuilt and will be charged into the new furnaces with ore. The loss in the present practice is believed to be very small.

For some time oil was used as fuel in the New Idria plant, but although this was very satisfactory as far as complete economy of consumption and regulation of supply were concerned, it has been found cheaper to burn wood when it can be had. The latter is now cut under very satisfactory arrangements on near by forest reserves, and is chiefly manzanita and oak. About 8 cords are required for fuel every twenty-four hours, the fuel value of the pyrite in the ore enabling very good furnace practice with this amount.

About 240 tons of ore are mined and treated every day of twenty-four hours. The plant is in operation six days of the week on three shifts per day. The quicksilver is hauled over 60 miles of fairly good road to Tres Pinos, in wagons drawn by 6 to 10 mules, the return trains bringing supplies for the mines. Power and light are obtained from Pelton wheels under high head from San Carlos Creek. There were about 175 men employed underground in 1908, and about 2,150 feet of drifts were run during the year.

The San Carlos mine, of the New Idria Company, on San Carlos Mountain, about 1 mile southeast of New Idria, was prospected, but did not produce in 1908.

San Luis Obispo County.—In San Luis Obispo County the Oceanic and the Klau mines were the chief producers in 1908. The Oceanic mine, in the Oceanic district, was worked under lease. The Klau mine, near Klau, in the Adelaide district, produced no ore, the output of quicksilver for the year being derived from cleaning out old condensers. The name of this mine has been changed to Sierra Morano. There is a 60-ton Scott furnace on the property. The Cambria mine was closed down in December, 1907. The Madrone Quicksilver Company, controlling the Madrone mine, went out of business during the year. The Josephine mine, in the Adelaide

[a] Forstner, William, op. cit., p. 214.

district, also produced a small tonnage during development work. The Cypress Mountain mine did not produce.

Santa Barbara County.—In Santa Barbara County there was no production in 1908, the Acachuma and Eagle mines both being idle.

Santa Clara County.—In Santa Clara County the New Almaden district, for many years the greatest producer of quicksilver in the United States, lies 13 miles southeast of San Jose on the eastern slopes of the Gabilan Range and in the Santa Clara Valley. The producing mines in 1908 were the New Almaden and the Guadalupe, and those from which no production was reported were the Phoenix, San Juan, Santa Teresa, and Silver Creek. The New Almaden mine for a long period was the largest producer in the United States. It has been a producer from 1824 to the present time. The output from both the Almaden and the Euriqueta mines, as given in published reports covering the period from 1850 to 1896, was 953,018 flasks of 76½ pounds each, or 72,905,877 pounds, or 36,453 tons of quicksilver.[a] During this period 797,025 short tons of ore yielded 72,097,196 pounds of metal from the New Almaden mine, the average recovery being equivalent to 4.52 per cent of metal per ton treated. The yield from ore has decreased from 36.74 per cent in 1850–51 to 0.74 per cent in 1895–96. Since the last year named the production has not been made public. The New Almaden district has been frequently described.[b]

The new Almaden plant includes 2 coarse-ore furnaces with a total daily capacity of 40 tons, and 3 Scott continuous fine-ore furnaces, with a total daily capacity of 104 tons. The Guadalupe mine is equipped with 2 coarse-ore and 2 fine-ore furnaces, with a total daily capacity of 120 tons. The Phoenix mine has a modern 60-ton Scott furnace, the San Juan is equipped with 24 retorts, and the Santa Teresa mine has a 40-ton continuous Scott furnace.

Siskiyou and Solano counties.—In Siskiyou County the Minnie Ah! Ah! and Siskiyou mines, in the Oak Bar district, did not produce in 1908, prospecting only being done. In Solano County the St. John mine, near Vallejo, was again a producer. The plant includes 2 coarse-ore furnaces of the Neat type and 24 pipe retorts. Coke has been used for fuel, but has not given satisfaction, particularly with the retorts. A 60-ton fine-ore furnace will probably be built to replace the retorts, and oil will be used as fuel.

Sonoma County.—In Sonoma County the Culver-Baer, Great Eastern, and Socrates companies produced quicksilver in 1908. The old Fitzgerald furnace of the Culver-Baer was being replaced by a 40-ton Scott furnace. The Cloverdale mine, equipped with a 14-ton furnace, did not produce in 1908. The Great Eastern mine, near

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[a] Forstner, William, op. cit., p. 177.

[b] Mason, Richard B., Letter from Col. Richard B. Mason: Reports of the Secretary of War (H. Doc. 17, 31st. Cong., 1st. sess.), 1850, pp. 528–536. (Gives a description of the quicksilver mines near San Jose.)

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Guerneville, was not operated during the year, the production being derived from the cleaning up of the plant during six months of 1908. The company has a 16-ton Scott furnace, a 12-ton coarse-ore furnace, and retorts. The Socrates mine made a small production during development while under bond to the Socrates Development Company. The Hurley, Boston, Pacific, Sonoma, and Double Star mines near Pine Flat were not operated, and development work only was done on the Cinnabar King and Eureka mines.

Stanislaus, Trinity, and Yolo counties.—There was no production reported from Stanislaus and Yolo counties in 1908. In Trinity County there was a small output by the Altoona Company, resulting from working over old dumps. The Integral mine was closed down.

TEXAS.

The production of quicksilver in Texas in 1908, all from the Terlingua district, in Brewster county, was 2,382 flasks of 75 pounds each, a decrease of 1,304 flasks as compared with the output of 1907. At the close of the year, however, the outlook was bright for an increased output in 1909. The following table shows the production in Texas by years:

Production of quicksilver in Texas, 1899–1908, in flasks.

1899	1,000	1905	4,723
1900	1,800	1906	4,761
1901	2,932	1907	3,686
1902	5,319	1908	2,382
1903	5,029		
1904	5,336		36,968

The mines of the Big Bend Cinnabar Company have been closed down for two years. The Texas Almaden Mining Company, whose plant includes a 20-ton Scott furnace, has been chiefly occupied in developing and prospecting with diamond drills. The Marfa and Mariposa Mining Company produced through operations of its 20-ton furnace, but the Lone Star Company reported no production during the year. The Chisos Company was again an important producer.

The quicksilver deposits of Texas have been described by Phillips and Turner,[a] and the available information was summarized by the writer in Mineral Resources for 1907.[b]

UTAH.

There was no production of quicksilver in Utah in 1908. The only producer in 1906 and 1907, the Sacramento Gold Mining Company, whose mines are at Mercur, in Tooele County, closed down its properties in 1907.

OREGON.

In Oregon there was a small production reported from the Black Butte mines, in Lane County, and by the Almaden Quicksilver and Gold Mining Company operating in Crook County. The former company has completed a Dennis 36-ton furnace, and the latter company

[a] Phillips, Wm. B., The quicksilver deposits of Brewster County, Texas: Econ. Geol., vol. 1, 1906, pp. 155–162.
Turner, H. W., The Terlingua quicksilver deposits: Econ. Geol., vol. 1, 1906, pp. 265–280.
[b] McCaskey, H. D., Quicksilver: Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, pp. 681–682.

has a 6-ton furnace. Considerable prospecting was reported by the Almaden Company, in 1908, and by the Scotia Development Company, operating near Drew, in Douglas County.

NEVADA.

In Nevada there was important development and prospecting of quicksilver deposits in 1908, and in the old Union district in Nye County a small quantity of quicksilver was produced, but not marketed, by the Shoshone Quicksilver Company during trial runs of a retort plant used in testing ore. This company has been actively prospecting some promising deposits, and reported considerable pay ore developed. The Bishop Quicksilver Mining Company, whose claims are in the same district, stopped work in 1908. The Nevada Almaden Mining Company has had 22 claims under continued development in Indian, Humboldt Mountain, and American Canyon districts.

ARIZONA.

In Arizona there was a small production in 1908 by the Colonial Mining Company, whose properties are near Quartzite, in Yuma County, during experiments on ore and furnace covering five months. The furnace is a 30-ton Scott tile furnace, but the brick available for constructing the condensers proved too porous for economical practice, as it absorbed a large amount of mercury.

WORLD'S PRODUCTION.

The following table gives the world's production of quicksilver, in metric tons, of 2,204.6 pounds, for the years 1903–1908. For foreign countries the quantities given are partly from the corrected figures of the Fifteenth Annual Issue of Comparative Statistics, compiled by the Metallgesellschaft, Metallurgischen Gesellschaft A. G., and the Berg- und Metallbank Aktiengesellschaft, of Frankfort on the Main, Germany; for the United States the figures are those of the United States Geological Survey; and for Spain for 1907 and 1908 they are those of United States Consular Agent A. E. Carleton, published in the Daily Consular and Trade Report No. 3585.

World's production of quicksilver, 1903–1908, in metric tons.

Country.	1903.	1904.	1905.	1906.	1907.	1908.
United States	1,237	1,188	1,036	892	734	672
Austria	575	550	570	577	610	630
Italy	313	357	369	418	423	680
Russia	362	332	318	210	130	49
Spain	968	1,130	853	1,567	1,210	1,065
Mexico	188	[a] 190	[a] 190	[a] 200	[a] 200	[a] 200
	3,643	3,747	3,336	3,864	3,307	3,296

[a] Partly estimated.

IMPORTS AND EXPORTS.

According to returns from the Bureau of Statistics of the Department of Commerce and Labor the imports of quicksilver into the United States in 1908 were less than those of 1907, but were greatly in excess of those of years preceding 1907. The exports were greatly

decreased in 1908, as compared with those of 1907. The excess in value of exports over imports was $116,744 in 1908, as compared with $185,373 in 1907 and with $243,864 in 1906.

Quicksilver imported and entered for consumption in the United States, 1904–1908, in pounds.

Year.	Quantity.	Value.
1904	(a)	$1,405
1905	2,690	1,710
1906	84	50
1907	16,567	6,719
1908	15,113	8,216

[a] Not stated.

Exports of quicksilver from the United States, 1904–1908, in flasks.[b]

Year.	Quantity.	Value.
1904	21,064	$847,108
1905	13,534	489,756
1906	6,456	243,914
1907	5,132	192,094
1908	2,996	124,960

[b] Flasks 76½ pounds net; 75 pounds net since June 1, 1904.

The imports were almost wholly into the port of New York, as they were in 1907. In 1908 there were entered in New York 15,000 pounds, valued at $8,123, from England, as against 15,939 pounds, valued at $6,414, from Canada in 1907; and 5 pounds, valued at $3, as against 520 pounds, valued at $230 in 1907, from Germany.

As the foreign market for domestic production is of much interest to those engaged in the industry the following tables have been prepared giving the distribution in detail of exports from the United States by countries to which export was made in 1907 and 1908.

Exports of domestic quicksilver from the United States in 1907 and 1908, by foreign countries, in pounds.

Country.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Canada	34,364	$18,204	74,231	$38,401
Costa Rica	3,750	1,961	.....	.....
Guatamala	150	78	196	110
Honduras	17,546	9,308	1,260	698
Nicaragua	1,545	851	1,951	1,100
Panama	176	90	84	54
Salvador	677	315	600	348
Mexico	174,740	96,423	141,434	81,306
Cuba	225	116	361	225
Santo Domingo	.....	.....	90	47
Brazil	.....	.....	1,224	720
Colombia	370	248	1,413	836
Ecuador	534	339	330	205
Peru	86	54	.....	.....
Venezuela	.....	.....	90	43
Hongkong	150,000	63,787	.....	.....
Japan	750	320	.....	.....
Korea	.....	.....	1,275	780
Philippines	.....	.....	153	87
	384,913	192,094	224,692	124,960

From this table it will be noted that the total exports to Canada more than doubled in 1908, and that there were increases over the exports of 1907 to Brazil, Colombia, Korea, and the Philippines; but that the important export to China ceased entirely in 1908, and that there were decreased exports to Costa Rica, Honduras, Mexico, and Japan. The total decrease in exports from the United States in 1908 is about equivalent to that in exports from San Francisco to Hongkong.

In the following table are given the exports from San Francisco, the most important shipping point, in 1907 and 1908:

Exports of domestic quicksilver from San Francisco in 1907 and 1908, by countries, in flasks of 75 pounds.

Country.	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
Canada	7	$272	5	$268
Costa Rica	50	1,961	.....	.....
Honduras	234	9,308	.....	.....
Nicaragua	.....	.....	4	130
Salvador	8	268	8	348
Mexico	1,706	67,170	1,453	63,436
Hongkong	2,000	63,787	.....	.....
Japan	10	320	.....	.....
Korea	2	78	17	780
Philippines	.....	.....	2	87
	4,017	143,164	1,489	65,049

PRICES.

Prices of quicksilver continued in 1908 the improvement begun in 1907. In New York the average price for 1907 was $41.50 and the average quotation for domestic quicksilver in San Francisco was $39.60, and for export, $38.17; in 1908 these average prices had risen, respectively, to $44.84, $44.17, and $42.54. The New York price began the year 1908 at $45, where it remained until it dropped to $44.25 in June, $44 in July, $43.30 in August, and $42.87 in September. In October it rose sharply to $46.25, and it reached the high mark of $46.60 in November, closing the year at $45.75 in December. The San Francisco prices were $45 for domestic and $43.50 for export until May, when the drop to $44.50 and $43 began, continuing in June to $44 and $42.50, in July to $43.50 and $42, in August to $42.70 and $41.30, and in September to $42.25 and $40.50; in October the prices rose to $43.50 and $41.62, in November to $44.50 and $42.50, and in December to $45.12 and $43.12.[a]

The average price reported by producers to the United States Geological Survey was $38.43½ in 1907 and $41.72½ in 1908.

In London the highest price was £8 10s. and the lowest £7 12s. 6d. per bottle of 34.5 kilos.[b]

[a] Eng. and Min. Jour., vol. 87, 1909, p. 141.

[b] Comparative Statistics of Lead, Copper, Spelter, Tin, Aluminum, Nickel, Quicksilver, and Silver, compiled by the Metallgesellschaft, the Metallurgischen Gesellschaft A.-G., and the Berg- und Metallbank Aktiengesellschaft, Frankfort on the Main, 15th Annual Issue, July, 1909, p. 102.

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[a] McCaskey, H. D., op. cit., pp. 689–692.

BAUXITE AND ALUMINUM.

By W. C. Phalen.

BAUXITE.

PRODUCTION.

The production of bauxite in the United States in 1908 amounted to 52,167 long tons, valued at $263,968, a decrease of 45,609 tons, or nearly 47 per cent in quantity, and of $216,362, or 45 per cent in value, as compared with the production of 1907. The average price of the material at the mines was about $5.06 per long ton, an advance of $0.15 over the price in 1907.

The list of States producing bauxite on a commercial scale remains as in 1907. These States are Alabama, Arkansas, Georgia, and Tennessee. As in past years, Arkansas leads in production with an output of considerably more than 60 per cent of the total. The actual production of this State, however, fell off about 43 per cent, and that of Georgia and Tennessee also decreased; the production of Alabama increased.

The following table gives the production and value of bauxite from 1889 to 1908, inclusive. In the collection of these statistics, the cordial cooperation of the state geologists of Georgia and Alabama in their respective States is hereby acknowledged.

Production of bauxite in the United States, 1889–1908, by States, in long tons.

Year.	Georgia.	Alabama.	Arkansas.	Total.	Value.
1889	728			728	$2,366
1890	1,844			1,844	6,012
1891	3,301	292		3,593	11,675
1892	5,110	5,408		10,518	34,183
1893	2,415	6,764		9,179	29,507
1894	2,050	9,016		11,066	35,818
1895	3,756	13,313		17,069	44,000
1896	7,313	11,051		18,364	47,338
1897	7,507	13,083		20,590	57,652
1898				25,149	75,437
1899	15,736	14,499	5,045	35,280	125,598
1900	19,739		3,445	23,184	89,676
1901	18,038		867	18,905	79,914
1902	22,677		4,645	27,322	120,366
1903	22,374		25,713	48,087	171,306
1904	21,913		25,748	47,661	235,704
1905	15,173		32,956	48,129	240,292
1906	25,065		50,267	75,332	368,311
1907				[a] 97,776	480,330
1908	14,464		[a] 37,703	52,167	263,968

[a] Production of Tennessee included.

CONSUMPTION.

The following table shows the annual production, imports, consumption, and value of bauxite in the United States during the last five years:

Production, imports, and consumption of bauxite in United States, 1904–1908, in long tons.

Year.	Production.		Imports.		Consumption.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	47,661	$235,704	15,374	$49,257	63,035	$285,961
1905	48,129	240,292	11,726	46,517	59,855	286,809
1906	75,332	368,311	17,809	63,221	93,141	431,532
1907	97,776	480,330	25,066	93,208	122,842	573,538
1908	52,167	263,968	21,679	87,823	73,846	351,791

WORLD'S PRODUCTION.

The following table shows the world's production of bauxite from 1905 to 1907, inclusive:

World's production of bauxite, 1905–1907, in long tons.

Country.	1905.		1906.		1907.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	48.129	$240,292	75,332	$368,311	97,776	$480,330
France	101,378	205,738	115,926	229,952	155,512	318,206
United Kingdom	7,300	8,880	6,654	13,274	7,480	9,168
Total	156,807	454,910	197,912	611,537	260,768	807,704

NOTES ON THE BAUXITE INDUSTRY.

Few changes took place in the bauxite industry during 1908. The industrial depression which began in the fall of 1907 and extended into the year 1908 was felt in the bauxite and aluminum industry as well as in others. There was little or no new development or prospecting work done. Numerous new discoveries of bauxite, however, have been reported. An occurrence has been reported near Allentown, Pa., and another occurrence was visited by the writer about 7½ miles northwest of Fort Payne, Dekalb County, Ala. The latter deposit is located a short distance from Big Will Creek, and the nearest station is Cordell, on the Alabama Great Southern Railroad. A few prospect pits have been sunk at this locality, an open cut has been dug, a shaft 50 feet deep has been made, and a few tons of ore have been thrown out. In the immediate vicinity numerous pockets of iron ore have been prospected, but, so far as known, no bauxite has ever been shipped from the locality.

Virginia.—A deposit of bauxite ore in Virginia has been brought to the writer's attention by E. C. Harder, of the United States Geological Survey, who has supplied the following data regarding it:

The bauxite is found in Botetourt County, Va., about 2 miles east of Troutville, at the old Houston iron and manganese mines. The mines consist of two large open cuts about half a mile apart, and the bauxite occurs, though probably not in commercial quantity, in the westernmost of these. The cuts are in variegated clay at the foot of the Blue Ridge.

The rocks of eastern Botetourt County are of Cambrian age and have the following succession, beginning with the highest beds:

Natural Bridge limestone.
"Buena Vista" shale.
Sherwood limestone.
Lower Cambrian quartzite.
Lower Cambrian quartzite and shale.

The lower Cambrian quartzite forms the western slope of the Blue Ridge. The Sherwood limestone and the "Buena Vista" shale form a gently sloping shelf at its foot, and the Natural Bridge limestone the valley to the west. Near the foot of the Blue Ridge the rocks are concealed by a considerable thickness of variegated clay and sand, most of which is residual, but part of which may be of fluviatile origin. The iron and manganese ores and the bauxite occur in these clays at or near the contact of the lower Cambrian quartzite with the overlying formation. The bauxite is associated with iron and manganese ores in bright-colored red, orange, brown, and pink clays lying on partly decomposed sandstone, horses of which extend upward into the clay. Most of the manganese ores occur as a replacement of the sandstone in these horses and in dark-colored clays immediately in contact with them. The iron ores, some of the manganese ores, and the bauxite occur in the variegated clays, the iron and manganese being in the form of irregular fragments and the bauxite in scattered masses. The clay forms a sort of blanket deposit over the decomposed sandstone and has an average thickness of from 15 to 30 feet, so that the ores associated with it are surface occurrences and do not extend to a great depth. The bauxite has a pisolitic texture and, as a rule, is highly ferruginous and dark red in color. Some of the ore, however, is light red or yellow. The pisolites vary in diameter from one-tenth inch to one inch, and consist of a thin shell composed of concentric layers; the interior is structureless, but usually porous and cellular.

New bauxite field in Georgia.—In the report for 1907 on the occurrence of bauxite, a note was given on a new field in Wilkinson County, Ga. Since that time, this new field has been studied in much greater detail by Otto Veatch, of the Geological Survey of Georgia,[a] from whose article the following notes are in part abstracted and in part quoted.

The deposits are in no way connected with those of northwestern Georgia, either geographically or geologically, being located 150 miles distant and near the margin of the coastal plain. Macon is the nearest city, located 30 miles to the west. The bauxite apparently occurs near the contact between the Tuscaloosa (Lower Cretaceous) and Claiborne (Tertiary) formations which are chiefly made up of unconsolidated clays and sands, lying practically flat and having no pronounced structural features. The bauxite occurs in the form of beds either resting directly upon the Cretaceous clays or disseminated as nodules through them. Bauxite beds 10 feet thick have been observed.

The ore is generally either pisolitic or concretionary, but it is also amorphous, in which case it may be dense, halloysitic, or even flinty in appearance. Its color varies from almost white or cream to a bright red. It is generally hard, and no soft, granular, or claylike varieties have yet been discovered.

[a] Veatch, Otto, The bauxite deposits of Wilkinson County, Ga.: Bull. Geol. Survey Georgia No. 18, 1909, pp. 430–447.

The following analyses, made by Edgar Everhart, chemist of the Geological Survey of Georgia, show the composition of the ore:

Analyses of bauxite from Wilkinson County, Ga.[a]

No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	H_2O	Moisture.	Undetermined.
1	52.92	7.66	10.17	2.30	26.55	0.35	.....
2	57.58	.96	9.38	2.76	29.12	.35	.....
3	41.97	18.24	17.50	2.65	16.38	2.65	0.16
4	57.36	1.94	.90	3.65	32.44	.67	3.04
5	42.73	14.99	15.57	1.84	20.29	2.79	.....
6	61.77	1.67	.90	2.26	31.77	.95	.....
7	60.64	1.33	2.30	2.00	30.58	2.79	.....
8	61.00	1.94	.74	2.66	32.93	.46	.....
9	60.54	1.94	1.96	2.01	32.51	.35	.....
10	62.46	.81	4.72	.23	31.03	.....	.....
11	49.94	9.32	8.32	1.98	27.24	1.94	.....
12	39.92	16.84	20.00	1.47	19.52	1.25	.....
13	60.55	1.89	2.12	1.96	32.97	.....	.....
14	61.52	1.70	1.18	2.70	32.76	.....	.14

[a] Analyst, Edgar Everhart.

According to Veatch:[a]

The origin of the bauxite is obscure. The geological conditions under which it formed were evidently different from those of the Georgia-Alabama and the Arkansas districts, and it is not believed that the theories advanced in explanation of those deposits are applicable to the Wilkinson County bauxite.

The close association of the Wilkinson County bauxite with the white clays and sedimentary kaolins of the Cretaceous at once suggest these clays as the source of the alumina of the bauxite. The facts collected in the field and the chemical analyses favor most strongly the theory that the bauxite has resulted from a chemical alteration in place of pure clays. The following analyses suggest a gradation from clay to bauxite:

Analyses showing gradation of clay to bauxite.[a]

	1.	2.	3.	4.	5.	6.
Moisture	0.35	0.89	0.78	.....	0.33	.....
H_2O	13.70	14.10	14.54	18.12	29.10	32.97
Al_2O_3	38.24	39.34	40.91	43.50	55.21	60.55
SiO_2 (total)	45.39	[b] 43.57	[c] 41.21	33.34	12.40	2.12
SiO_2 (sand)	.93	1.12	5.63	.....	.....	.....
Fe_2O_3	1.01	.72	.81	1.89	.96	1.89
TiO_2	1.76	1.61	1.52	1.53	2.15	1.96
CaO	.10	None.	.....	.....	.....	.....
MgO	Trace.	.10	.12	.....	.....	.....
Na_2O	Trace.	.05	.04	.....	.....	.....
K_2O	Trace.	.10	.24	.....	.....	.....
Total	100.55	100.48	100.12	98.38	100.15	99.49

[a] Analyst, Edgar Everhart. [b] Soluble silica 5.28 per cent. [c] Soluble silica 4.82 per cent.

All of the samples are from Wilkinson County. No. 1 is an unaltered white clay, and is representative of extensive beds which occur in Wilkinson and adjoining counties. Nos. 2 and 3 are semi-indurated clays, which contain coarse nodules and concretions and have the appearance of bauxite; Nos. 4 and 5 show a further decrease in silica, and No. 6 is a relatively pure bauxite. The silica in Nos. 4, 5, and 6 exists mainly in combination with alumina as clay and partly as soluble silica, but does not exist in appreciable percentages as free silica or quartz sand.

In the field samples of clay may be observed which in their physical appearance suggest an alteration process to bauxite. These clays are semihard, mealy, and have lost some of their plasticity; they contain both nodules without

[a] Op. cit., pp. 436–439.

concretionary structure and concretions, giving the whole the appearance of bauxite. Analyses show, however, not only a small excess of alumina over silica, but also that a part of the silica exists in a soluble form. These clays form the upper part (in contact with the Tertiary) of massive nonlaminated, white clay beds which may reach a thickness of 30 feet; the lower part of these beds is structureless, soft clay, but there is no sharp line between the two. Frequently the nodules and concretions weather out of the clay, giving the clay a pitted and honeycombed appearance. At one locality irregularly shaped nodules of bauxite were scattered through the soil and were evidently derived by a weathering-out process, probably from a bauxite clay. Concretions have been observed, which, though possessing a distinct concentric structure, seem to be kaolin. It is not unlikely that these concretions upon closer examination will show a high percentage of soluble silica, or silica not in combination with alumina as in kaolin. Specimens may also be obtained which are part clay and part bauxite, and not simply mechanical mixtures which may have resulted after the formation of the bauxite.

Bowlders of relatively pure bauxite, together with fragments of pitted clay, are very often found in the soil lying upon the beds of honeycombed or pitted kaolins.

Assuming then that the bauxite was derived by a chemical process from the clay, what was the chemical solvent which affected the change, and under what conditions? The manner in which a relatively pure clay or kaolin could be decomposed with the formation of bauxite confessedly offers a difficult problem. The most satisfactory conclusion which the writer can come to, considering the limited opportunity of collecting facts, since the bauxite is as yet wholly undeveloped, is that the kaolin and other clay may have been altered by circulating highly alkaline waters of meteoric origin. The alkaline carbonates as sodium carbonate or bicarbonate, $NaHCO_3$, may have been formed by the action of carbonic acid on alkaline silicates or other alkaline salts in the overlying Tertiary, and being taken into solution by circulating waters issued as springs near the contact of the Tertiary with the impervious white clays of the underlying Cretaceous. The action of the sodium carbonate on the kaolin would result in the desilication of the kaolin with the formation of a sodium silicate, leaving an aluminous hydroxide in a gelatinous or colloidal condition. The action of alkaline carbonates upon the clay would take place more readily were the waters carrying them in solution heated.

The conclusion is that the bauxite has been derived by the action of a decomposing agent upon the clay, whatever this chemical may have been, or its source. Certainly this chemical must have been a more powerful solvent than carbonic acid, and the alteration was effected by other than simple weathering agencies. The possibility of thermal waters derived from the near-by igneous rocks of the Piedmont Plateau or those underlying the sediments effecting the alteration was considered, but under the geologic conditions this seems to have little evidence in its favor. Waters carrying sulphuric acid would be capable of decomposing the clay, but the source of the acid would be difficult to explain, since, so far as known, the overlying Tertiary and the Cretaceous contain no appreciable amounts of sulphur compounds.

A number of occurrences have been reported, but no development work and very little prospecting has been done. The principal localities where bauxite has been found are: (1) three miles northeast of McIntyre on the property of Mrs. W. R. Parker, J. R. Honeycutt, W. E. Honeycutt, and James Daniel; (2) five miles north of McIntyre on the property of J. U. Parker; (3) at McIntyre station, on the property of Dr. W. A. Parker; (4) three miles west of McIntyre on the Holleman property; (5) three miles east of McIntyre on the property of R. W. Adkins; (6) three miles west of Toomsboro on the property of Dr. N. T. Carswell; (7) on the old Chambers place, 1½ miles southwest of Irwinton; (8) on the J. R. McNeal place, 5 miles west of Irwinton; (9) six miles southeast of Gordon, on the Vincent property owned by W. A. Jones, of Gordon; (10) on the property of Mrs. Z. T. Miller, 3½ miles south of Gordon; (11) on the farm of J. I. Etheridge, 2 miles southeast of Coopers Station.

For a full description of the various localities enumerated the reader is referred to Veatch's article cited above.

The points at which the bauxite is most likely to occur may be approximately located by finding the white clay beds, locally known as the "chalk" beds, as the bauxite has been found contiguous to the clay and near its contact with the overlying red sands and impure clays. The geologic conditions obtaining in Wilkinson County are also found in Twiggs, Washington, Glascock, McDuffie, and Richmond counties, and bauxite may be found in any or all of these.

Tennessee field.—The bauxite deposits occurring in Missionary Ridge, near Chattanooga, were worked during 1908 by only one company, the National Bauxite Company. This company worked two pits during the year, known as the Perry mines, Nos. 1 and 2. At the former mine, operations were conducted during the early part of the year, but the spring rains caused a cessation of the work. There is still some good ore remaining, however. Operations at Perry mine No. 2 were begun in August, and it was expected that this mine would be worked during the rest of 1908 and would furnish the main tonnage from this district.

A new log washer and a revolving cylindrical drier were erected by the company during the year and were completed in April. They have been used more or less intermittently ever since. The ore from the Missionary Ridge mines is carted to a belt line on the ridge and hauled on this to the main railroad line. The Aluminum Company of America has done no work in the Tennessee field, and no prospecting work has been done in this district since the financial depression of the fall of 1907.

Georgia-Alabama field.—Conditions in the Georgia-Alabama field were not so good in 1908 as during 1907. The general demand for bauxite, both by the alum manufacturers and the manufacturers of metallic aluminum, has been slight, and the depression has been keenly felt. The Aluminum Company of America has worked at the Watters property near Hermitage and has done some exploratory work near the Monahan mine near Rock Run, Ala. A little work has been done at the Reese mine, located a few miles south of Cave Spring, Ga., and some good ore has been found. Most of the company's ore has been dried at Cave Spring. Mr. John H. Hawkins has also done some work near Hermitage. The Republic Mining and Manufacturing Company has done some work at the Dike mine near Rock Run, Ala., and is reported to have mined a little ore near Hall's Station on the Western and Atlantic Railroad, 18 or 20 miles northeast of Rome and about 5 miles from Kingston. The National Bauxite Company has done some work at the Hebble mine, about 4 miles south of Cave Spring. This is one of the largest openings in the district. Nothing has been done at the Gordon property, though there is still some ore there.

ALUMINUM.

PRODUCTION AND CONSUMPTION.

The aluminum industry, like other metal industries, felt and still feels the effects of the financial depression of 1907. The amount of metal being used at the beginning of 1909 was no greater than during 1906, before the extensive additions to plant equipments took place.

At the close of the year 1907 quotations on metallic aluminum ranged from 37 to 39 cents per pound, with the trade very dull. About the middle of January, 1908, revised prices were issued as follows: No. 1 ingots, 99 per cent pure, 33 cents per pound in ton lots; No. 2 ingots, 32 cents per pound. About the middle of April quotations on No. 1 ingots remained the same, with a base price on rods and wire of 38 cents and on sheets of 40 cents. These prices held steadily until the month of October, but foreign metal was occasionally offered at rather lower prices. During the latter half of October there was a considerable reduction in prices. The base price of ingots fell to 26 cents, and that of sheets to 35 cents per pound. At the end of October a further reduction to 25½ cents per pound in ton lots for No. 1 ingots occurred, while in lots smaller than a ton the price was 26½ cents. During the earlier part of the month the understanding among the European producers expired, and on account of the great excess of productive capacity and the accumulation of a large unsold stock strong competition developed and the prices fell to 13½ and 14 cents. High-grade French aluminum was offered at 23 cents per pound at the end of October. About the middle of November the nominal price of the American producers remained as stated, but high-grade foreign aluminum was offered as low as 22½ cents, falling to 22 cents at the close of the month. At the end of November the Aluminum Company of America quoted 24 cents as the base price for No. 1 ingots and 33 to 34 cents as the base price for sheets. Foreign aluminum was offered at 22 cents for ingots. The range of the market in America, therefore, was from 22 to 24 cents, while in Europe the metal was quoted at 13½ and 14 cents. These prices were maintained throughout December until the close of 1908, and also obtained during January, 1909. It is noteworthy that in 1908 aluminum sold in Europe for less than copper, pound for pound.

The magnitude of the aluminum industry is shown by the following table, which gives the production since the beginning of the industry in 1883:

Production, in pounds, of aluminum in the United States, 1883–1908.

1883	83	1897	4,000,000
1884	150	1898	5,200,000
1885	283	1899	6,500,000
1886	3,000	1900	7,150,000
1887	18,000	1901	7,150,000
1888	19,000	1902	7,300,000
1889	47,468	1903	7,500,000
1890	61,281	1904	[a] 8,600,000
1891	150,000	1905	[a] 11,347,000
1892	259,885	1906	[a] 14,910,000
1893	333,629	1907	[a] 17,211,000
1894	550,000	1908	[a] 11,152,000
1895	920,000		
1896	1,300,000	Total	111,682,779

The value of the exports of aluminum and manufactures of aluminum of domestic production for the last five years has been as follows: 1908, $330,092; 1907, $304,938; 1906, $364,251; 1905, $290,777; 1904, $166,876.

[a] Consumption.

PROGRESS OF THE ALUMINUM INDUSTRY.

A recent event of importance in the aluminum industry was the expiration on February 2, 1909, of the Bradley patent. As has already been noted, the Hall patent expired April 2, 1906.

In a recent number of Metal Industry, the progress in the aluminum industry for the last twenty years has been concisely described by an anonymous writer.[a] As is well known, the business in the United States is in the hands of a single company—the Aluminum Company of America—which controls extensive works located at Niagara Falls and Massena, N. Y., Shawenegan Falls, Quebec, Canada, and at East St. Louis, Ill. The new plant of the company, built recently at Niagara Falls, is known as No. 3. This is one of the largest plants of its kind in the world. It is furnished with power from the power house of the Niagara Falls Hydraulic Power and Manufacturing Company through 10 generators, each of 5,000 horsepower capacity, which are the largest direct current generators in point of capacity that have ever been built. The current is carried to the company's reduction plant and rolling mill by means of conductors consisting of aluminum bus-bars, one of the heaviest bus-bar lines in the world.

RECENT APPLICATIONS OF ALUMINUM.

The applications of aluminum have been recently summed up by J. T. W. Echevarri,[b] from whose article the following notes are in part taken:

Aluminum is used in iron and steel works for removing oxygen from the oxides of iron and other substances, the heat generated being so great as to raise the temperature of large bodies of iron. It also has the power of combining chemically with those gases imprisoned during the cooling of the metal, thus preventing porosity. For these purposes the metal is either used in the form of an alloy known as "ferroaluminum," or as the pure metal, either in the granulated or bar form or in small pieces weighing uniformly one-eighth ounce or one-fourth ounce each. This property of keeping molten metal hot or of raising the temperature of a molten metallic bath has been utilized in the thermit welding process, invented by Goldschmidt. In this process aluminum and iron oxide are intimately mixed in a finely divided state and ignited by means of a fuse. The heat of combustion in the ensuing reaction raises the temperature of the casting to the welding point. The reaction takes place in a funnel-shaped crucible, from which the fluid metal resulting from the reaction is run into a suitably shaped mold formed around the area of the joint to be made, which is preheated by means of a blow lamp to avoid chilling the first lot of metal coming through.

Aluminum is used in constantly increasing quantities in the motor-car industry, combining as it does both lightness and stiffness. It is used in making crank cases, gear boxes, carburetors, radiators, dash-boards, etc., besides in smaller ways. In castings it has been found advantageous to alloy the metal with copper, zinc, or nickel, which increases its strength and makes it easier to work.

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[a] The Metal Industry, vol. 7, No. 1, January, 1909, pp. 8–10.
[b] The Mining Journal, November 14 and 21, 1908.

Aluminum is one of the most malleable of all metals. Moreover, it takes and retains a very high polish. For these reasons it is used in connection with the manufacture of articles of everyday use almost without limit. Some of these new uses are as wall "paper," ceiling panels, stamped or hammered trays, finger plates, etc., in the form of very thin sheets; as a substitute for lithographic stones and zinc plates; and in the panels of car and carriage bodies. The advantages of aluminum in the manufacture of cooking utensils is well known; among these advantages are long life, noncorrosion from acids, and lightness.

In the form of powder aluminum is used to an increased extent in the manufacture of metallic paints and varnishes, its property of not tarnishing making it particularly suitable for this purpose. The paint is valuable in protecting iron and in rendering woodwork partly fireproof when applied in thick coats.

In the form of tubes it is used by acid and rubber manufacturers. A new product is bimetallic tubing, which is made of aluminum and steel, with the outer shell of aluminum and the inner of steel, or vice versa. The same combination may be made with aluminum and copper.

In America it is used to an increased extent in the transmission of electric power on a large scale. The Aluminum Company of America secured during 1908 the important contract for furnishing the transmission wires to be used in the electrification of the Southern Pacific Railroad Company's terminals in San Francisco. Copper is here replaced by aluminum. Another contract reported as having been received by the same company is that for the cable for a trolley road to Lake Winona, Wisconsin.[a]

The subject of the alloys of aluminum is so vast that it can only be briefly referred to here. Great strides have been made in the study of this subject in recent years. The alloys in most common use are those of aluminum combined with zinc, copper, and nickel. A new alloy which has attracted some attention is known as magnalium. As prepared by Dr. Ludwig Mach, 2 to 12 parts of magnesium added to 100 parts of aluminum produce an alloy lighter than aluminum and possessing the workability and strength of brass. One of the most valuable features of the alloy is the ease with which it can be turned, planed, or drilled.

ALUMINUM SALTS.

PRODUCTION.

There was a decrease of about 26 per cent in the quantity of alum produced in the United States in 1908 as compared with the production of 1907, and the quantity produced has dwindled to the proportions which obtained about five years ago. The quantity of aluminum sulphate also decreased about 9 per cent, and imports fell off 10 per cent. The following table shows the production of alum and aluminum sulphate for the years 1904 to 1908, inclusive.

[a] The Metal Industry, April, 1908.

Production and imports of aluminum salts into the United States, 1904–1908, in short tons.

Year.	Production.						Imports.[a]	
	Alum.			Aluminum sulphate.			Quantity.	Value.
	Quantity.	Value.	Per ton.	Quantity.	Value.	Per ton.		
1904	11,563	$319,189	$27.60	74,481	$1,417,867	$19.04	896	$19,991
1905	10,114	289,716	28.65	93,917	1,660,515	17.67	1,282	26,242
1906	15,613	450,125	28.83	89,246	1,613,050	18.07	1,183	23,193
1907	10,404	361,900	34.78	106,821	2,008,046	18.80	1,562	35,191
1908	7,700	236,710	30.74	97,255	1,835,213	18.87	1,407	24,929

[a] Includes alumina, aluminum hydrate, or refined bauxite, alum, alum cake, aluminum sulphate, aluminous cake, and alum in crystals or ground.

USES.

One of the principal uses of alum is in the paper trade where it is utilized for sizing or giving a hard finish to paper. Aluminum sulphate and also potash alum are used in the purification of water. Crystals of potash alum are also used in the dyeing trade. A small amount of alum is used in the manufacture of medicine. Recent experiments have shown the possibility of making carbonate of aluminum. The experimental work along this line was referred to in last year's report on bauxite and aluminum.

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ANTIMONY.

By Frank L. Hess.

PRODUCTION.

Only one lot of ore the value of which was wholly or principally confined to the antimony content was reported to the United States Geological Survey as having been mined and marketed in this country during 1908. This lot was mined from the Bloody Canyon mines near Mill City, Humboldt County, Nev. Some antimony ore was mined at Burke, Idaho, by the Stanley Consolidated Mining and Milling Company, but it was unsold. One metallurgical company in making antimonial lead used a little antimony ore of domestic production during the year, but the ore had been mined and sold in a previous year. Many gold and silver ores are also antimony bearing. When these ores are smelted the antimony combines with the lead of the charge to form antimonial lead, and by this indirect means a considerable output of antimony is produced, though it goes on the market as antimonial lead, for which there is a large demand and from which the metallic antimony is never separated. This alloy is used in type metal, babbitt, and other bearing metals, and in coffin trimmings, linings for acid tanks, toys, clock cases, and other articles for which a fairly hard metal to be gilded or otherwise finished is desired.

The production of antimony in the United States since 1903 has been as follows:

Production of antimony in the United States, 1903–1907, in short tons.

Year.	Contained in antimonial lead.		Antimony produced from foreign and domestic ore.	
	Quantity.	Value.	Quantity.	Value.
1903	2,558	$445,092	[a] 570	$103,341
1904	2,571	443,598	[b] 486	61,926
1905	2,747	588,354	493	117,433
1906	1,362	[d] 544,800	[c] 404	58,149
1907	[e]	.....	[c] 351	77,300
1908	[e]	.....	None.	None.

[a] Exclusive of foreign ores imported and re-exported.
[b] Estimated from the average content of the ore.
[c] Figured as 60 per cent of domestic ores only; direct figures from the smelters could not be obtained.
[d] Estimated from the prices current for the year.
[e] Included under antimonial lead.

At present China produces the greatest quantity of antimony ores. France, Italy, Austria, Bohemia, Turkey, Mexico, and New South Wales are all considerable producers and many other countries contribute smaller quantities to the world's supply.

IMPORTS.

The imports of antimony during 1908 were very large, though exceeded by both 1906 and 1907. Had it not been for the depressed state of trade, the figures for those years would probably have been exceeded in number of pounds, though prices were so much lower that the total value of the importations of 1907 will probably be the highest point reached for several years.

Antimony, antimony ore, and salts of antimony imported and entered for consumption in the United States, 1903–1908, in pounds.

Year.	Metal and regulus.		Crude antimony and ore.		Salts of antimony.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1903	4,694,309	$260,144	2,714,617	$54,316	916,468	$66,469	$380,929
1904	4,268,045	248,726	2,488,518	50,414	981,026	70,668	369,808
1905	4,941,247	431,228	1,970,788	53,026	1,010,228	80,130	564,384
1906	10,305,734	1,391,289	1,972,658	125,841	764,070	99,251	1,616,279
1907	9,600,901	1,407,861	2,771,387	180,903	682,192	98,038	1,686,802
1908	8,089,915	771,206	3,287,218	106,930	623,125	65,898	944,034

PRICES.

In 1906 the price of antimony of the best grade reached 28 cents a pound, and prices were high during the whole year. Prospectors and miners who owned or knew of obtainable antimony-bearing deposits became interested in producing the ore, and operations were begun in Washington, Idaho, Utah, Nevada, California, and Oregon. By the time some of the mines were in shape to ship the price of antimony had fallen. Although the year 1907 opened with Cookson's (the standard brand of antimony) at 26 cents, by August the price was down to 11 cents, and in December it was 9.5 cents. In 1908 the highest price was the same as the lowest of 1907, 9.5 cents, and the market fell still lower in the latter part of September to 8 cents per pound for Cookson's, the year closing at 8.2 cents. Ordinary brands sold about one-half cent per pound cheaper, with Hallett's about midway between in price.[a]

When compared with the prices of 1906 and 1907 the prices for antimony in 1908 seem low, but they were probably normal. In a few years, when the mines opened during the years of high prices have been abandoned or neglected through the discouragement of owners, the same forces that brought about the excessive prices of 1907 will likely again be able to raise them to the hurt of the consumer, for there can be little doubt that those prices were the result of market manipulation.

[a] The prices quoted are taken from the Engineering and Mining Journal.

USES.

The uses of the metal in antimonial lead, which were given in a former paragraph, form the chief modes of consumption.

Antimony is also used as an adulterant in solder and is considered a very objectionable element, especially when the solder is to be used for sealing cans holding provisions. Some antimony compounds are very poisonous, especially the organic compounds. The use of antimony salts and oxides is comparatively large, as shown by the importations. Antimony trioxide is used as a pigment in place of white lead, zinc oxide, etc., and seems to be gaining ground, especially in Europe. The trioxide is also used for making the glass used to coat iron in enameled ware, as a reducing agent in chemical work, and as a detector of alkaloids and phenols. Antimony arsenate, arsenite, trichloride, iodide, trioxide, trisulphide, pentasulphide, tartrate, and antimony and potassium tartrate are used in medicine. The trichloride, also called antimony butter, is used in bronzing iron, especially gun barrels, as a mordant for patent leather, in coloring zinc black, as a mordant for silver, and in the manufacture of lakes, particularly from dyewoods.

The double salts, antimony fluoride and ammonium sulphide, antimony and potassium oxalate, and antimony and potassium tartrate (tartar emetic) are used in dyeing.

The trisulphide is used in pyrotechnics for making "Bengal fire;" the pentasulphide, or golden sulphide, in coloring rubber goods; the antimonate in coloring glass yellow; vitreous antimony sulphide made by roasting antimony sulphide, then fusing the product with fresh antimony sulphide is also used to tint glass yellow, and for a like purpose with porcelain.[a] The chromate, under the name of "Naples yellow," is used as a fine artist's color. Naples yellow and some of the oxides are used as ceramic colors.

Antimony in the form of metal and oxide is used in making flint glass. About 1¼ pounds of each per ton of "batch" is used.

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[a] Merck's Index 1907 has been freely quoted as to uses of antimony oxides and salts.

BISMUTH.

By Frank L. Hess.

The United States has been a small producer of bismuth ores, and until the last two years these ores have been shipped abroad for reduction. The value of the imported bismuth and bismuth compounds has amounted to very much more than that of the ores exported.

The reduction of bismuth ores does not appear to be extraordinarily difficult, but the output of ore in this country has been so small that the large smelters have not cared to take hold of the matter and others did not feel that experimenting and the cost of a plant would be profitable. At some of the smelters a large quantity of bismuth has been wasted in fumes and flue dusts, and at others bismuth has been carried in the lead output and thus lost.

Harkins and Swain have estimated that 880 pounds of bismuth per day are being thrown off in the smoke[a] at the great Washoe smelter, Anaconda, Mont. This bismuth is undoubtedly not worth saving unless the company owning the smelter should find it expedient to save the flue dusts and fumes and work them over for the copper, lead, zinc, arsenic (part of which is now being saved), and other mineral products which are lost each day and which make an enormous aggregate. To do this does not now seem practicable, but the circumstance is mentioned to show one large potential source of the metal. The electrolytic process of refining lead has made the saving of bismuth carried in pig lead possible, and the United States Metals Refining Company, in 1906, erected a plant at Grasselli, Ind., where the Betts process is used to refine lead bullion from the company's smelter at Bingham Junction, near Salt Lake City. Most of the lead ores carrying bismuth come from the Tintic district, but the company buys gold and other ores carrying bismuth from other districts and States. A comparatively small quantity of bismuth was produced in 1908, but production was started on a much larger scale in 1909. The output is in the form of metal. The same company makes some bismuth at its copper refinery at Chrome, N. J., where the bismuth is recovered from the anode slimes formed in the electrolytic refining of copper.

The Monsanto Chemical Company, of St. Louis, Mo., also put in an electrolytic plant about the same time that the Grasselli plant was erected. The Monsanto Company recovered bismuth from lead bullion from the State of Sinaloa, Mexico, and a considerable recovery has been made, but the plant was closed during 1908.

George E. Stone, Engle, N. Mex., reports having mined bismuth ore from claims on the east side of the San Andreas Mountains, 4 miles north of the Dona Ana County line. The ore is made up of carbonates colored with copper and accompanied by some scheelite.

[a] Jour. Am. Chem. Soc., vol. 29, 1907, p. 994.

Practically all of the gold ores mined at Goldfield, Nev., carry bismuth, partly in the form of bismuthinite, and though not rich enough to work as bismuth ores they would much enrich such bismuth-bearing lead bullion as that produced in Utah by the United States Metals Refining Company.

The domestic production of bismuth in 1908 can not be disclosed.

Bolivia is a large producer of bismuth ores, but no figures upon the exports of bismuth ores since 1906 are obtainable. During that year bismuth to the value of $722,978 was exported.[a] It seems probable that somewhat over 200 metric tons of bismuth ore per year are shipped from Bolivia. Other countries that are either actual or possible producers of bismuth are Bohemia, Mexico, New South Wales, Norway, Peru, Portugal, Queensland, Saxony, Spain, and Tasmania.

Imports.—The imports of metallic bismuth for the last five years have been as follows:

Imports for consumption of metallic bismuth into the United States, 1904–1908, inclusive, in pounds.

Year.	Quantity.	Value.
1904	185,905	$339,058
1905	148,589	318,007
1906	254,733	318,452
1907	259,881	325,015
1908	164,793	257,397

Prices.—The price of bismuth during 1908, according to the Mining World, was $1.75 per pound, and of the subnitrate, according to the Engineering and Mining Journal, $1.50. These prices are currently reported to be fixed by Johnson, Matthey & Co., of London, who, by a trade agreement between foreign bismuth refiners, control the trade in France, England, and the United States. At the time the last previous bismuth report was issued by the United States Geological Survey (for 1906) the price for the metal had been put down to $1.25 per pound in order, it was believed, to extinguish competition that had started up. Supposedly, when this had been accomplished, in the middle of 1907, the price was put up to the figure mentioned for 1908, and has remained there since.

Uses.—Metallic bismuth is used in low-fusing alloys or cliche metals, which are used in the automatic sprinklers common in large stores, warehouses, etc., and in solders, some of which it is said to be possible to use under hot water which has been acidulated with hydrochloric acid. Some fuses for electrical wiring contain bismuth. A British patent (No. 23586, Dec. 24, 1900) uses the following formula: Bismuth, 50 parts (by weight); cadmium, 15 parts; lead, 20 parts; tin, 21 parts. The metal is used to a small extent in making optical glass. Several of the salts are used in face and toilet powders. The following salts, and probably others, are used in medicine: Albuminate, benzoate, borate, citrate, basic dithio salicylate, formic-iodide, lactate, trinitrate, subnitrate, and oxychloride. The chromate is used as an orange-yellow pigment, and the oxychloride as a white pigment. The subnitrate is used in the preparation of reagents for albumen and dextrose and for converting sulphides of arsenic into corresponding acids.[b]

[a] Sorsby, W. B., Daily Cons. and Trade Repts., April 9, 1907, p. 12.

[b] Merck's (1907) Index.

SELENIUM.

By Frank L. Hess.

Selenium is a rare and little-known element, closely related in many ways to sulphur and tellurium, with both of which it is found in nature.

With the recent great strides in the electro-refining of copper and the constant experiments in the possible uses of the rare elements, selenium is attracting some attention, as, on the one hand, the copper refineries find considerable quantities of the element in their slimes and desire to find a market for it as well as for other by-products, and, on the other hand, its peculiar characteristics incite effort on the part of experimenters to make use of them.

The principal source of selenium is in the anode muds or slimes of the electrolytic copper refineries. The American Smelters Securities plant at Baltimore, Md., the Perth Amboy and the Chrome, N. J., refineries have made more or less selenium, but the market is not yet large enough to take the possible output. The Baltimore and the Chrome refineries get their crude copper from many sources; that handled at Perth Amboy comes almost exclusively from Butte, Mont. Great tonnages of copper are handled at each of the smelters, and the selenium recovered represents only minute traces in the original ores. The peculiarity is presented, however, of this very easily volatilized element clinging to the copper through the high temperatures and oxidizing atmospheres in which the copper ore is treated.

The anode slimes in the copper refineries contain a large percentage, in many cases 50 per cent or more, of gold and silver. The slimes are treated in very large cupellation furnaces, as large as the reverberatory furnaces which a comparatively few years ago were used for copper smelting. Selenium is collected in the flue dusts from this cupellation, and is recovered by processes which differ with the refinery and which are hardly to be considered as more than experimental.

No selenides are known to have been observed in the Butte copper mines, and selenium is not known to have been detected in the ores by chemical analyses; the same remark applies to the other copper camps in the United States.

Selenium has been found in the mattes made from zinc-box precipitates of the Camp Bird mine, Colorado,[a] but is not detected in the ores. The mattes examined carried from 0.99 to 1.5 per cent of selenium.

[a] Headden, Wm. P., Some mattes formed in melting zinc-box precipitates, their composition, and what it suggests: Proc. Colorado Sci. Soc., Denver, read December 7, 1907, vol. 8, pp. 349-362.

The rarity of selenium minerals is shown by the fact that the only minerals and localities noted in the sixth edition (1892) of Dana's System of Mineralogy as occurring in the United States are:

"Tiemannite, mercury selenide (HgSe), near Clear Lake, California, and Marysvale, Utah.

"Onofrite, sulpho-selenide of mercury, Hg(S, Se), near Marysvale Utah."

No others are mentioned in the first appendix. Since the publication of this work J. E. Spurr[a] has described the occurrence of selenium in the Tonopah (Nevada) gold ores, where it is found, at least in part, as a silver selenide. The occurrence of considerable percentages of selenium in the gold bullion smelted from Tonopah and other Nevada ores is comparatively well known. Selenium in gold ores and bullion has been noted from a number of localities. The bullion from the Redjang Lebong mine, in the southwest part of Sumatra, carries 4.35 per cent of selenium.[b] Selenium is also said to occur in the Hauraki (New Zealand) gold fields.[c]

Dr. W. F. Hillebrand has identified a copper selenite in carnotite-bearing sandstones collected by Hoyt S. Gale in Routt County, Colo., during the summer of 1907.[d] It is without commercial importance.

Selenium, like sulphur, has several allotropic forms. As turned out by the refineries, it is an amorphous shiny black substance resembling in appearance pitch or some of the hard petroleum residues like albertite. It is harder and heavier (specific gravity about 4.3) than these, but very brittle, and corners can be broken with the finger nail. It is put out in the shape of round sticks one-half inch thick and about 4 inches long, as pigs 3 inches long by 1 inch broad, and as a coarse powder. From this amorphous form a red crystalline variety may be made by precipitation from carbon disulphide, alcohol, and other solvents. A "metallic" form is made by melting and slow cooling, or by slow heating.

The consumption of selenium in this country amounts to a few thousand pounds per year, and the price varies considerably, from $5 or $7 to $16 or even more per pound, according to amount and conditions of purchase.

Uses.—The greatest use of selenium is probably in glass, to which it gives a red color. This property is utilized both merely to overcome the green color of glass and also to give it a distinct red color, such as that of the glass used on railroads for signal lights. Selenite of soda is used to give a bright-red color to enamels used for covering steel. Selenium has the property of being a very poor conductor of electricity in the dark and a fairly good conductor in the light, and a number of electrical inventions depend on this peculiarity. Selenium has been used in instruments for measuring the Roentgen rays used in therapeutic applications; in automatic lighting and extinguishing gas buoys; and the statement is frequently made that it is used in Wheatstone bridges. It has been used in experiments in telephoning along a ray of light, and for transmitting sounds and photographs or other pictures to a distance by means of a telephone or telegraph wire.

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[a] Geology of the Tonopah mining district, Nevada: Prof. Paper U. S. Geol. Survey No. 42, 1905, p. 92.

[b] Trescott, S. J., The occurrence and mining of gold in the Dutch East Indies: Trans. Inst. Min. and Metallur., vol. 10, p. 54.

[c] Allen, F. B., Tellurium in the ores of the Hauraki gold fields: Trans. Australian Inst. Min. Eng., vol. 7, p. 98.

[d] Gale, Hoyt S., Carnotite and associated minerals in western Routt County, Colo.: Bull. U. S. Geol. Survey No. 340, 1908, p. 261.

Selenium cells for measuring the intensity of light have been constructed, and one such, made by coating a mica plate wrapped with platinum wire, is described by F. W. Huels.[a]

Selenium has been used as an embedding material for diatoms in microscopic work, sodium selenate as a reagent, and sodium selenite in bacteriology for showing the reducing properties of bacteria.[b]

Tests.—A test for selenium minerals is to heat them on charcoal before the blowpipe. Selenium gives a peculiar fetid odor, and if in sufficient quantity forms red fumes, part of which will be deposited on the cool charcoal as silvery white selenium oxide (SeO_2). If the blowpipe flame is turned upon this it burns with a fine characteristic blue flame. In the open tube selenium minerals will give a coating of selenium oxide, tinged red by selenium. This coating is volatile, and if driven out by heat into a colorless flame it will burn blue.

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[a] A comparison of the effect of frequency on the light of incandescent and Nernst lamps: Bull. Univ. Wisconsin, No. 157, Madison, 1907, pp. 419-423, 2 figs.

[b] Mercks Index, 1907.

TELLURIUM

By Frank L. Hess.

Large quantities of tellurium are found at Cripple Creek, Colo., combined with gold and silver to form calaverite and other tellurides. Smaller quantities of oxidized tellurium compounds also occur. In eight analyses of calaverite (in which form much the largest portion of the gold of the district is found), as published by Lindgren and Ransome,[a] the average percentage was: Tellurium, 57.17; gold, 41.16; silver, 1.65. The ratio of the tellurium to gold is, roughly, about 7:5. Taking this ratio as a basis, and considering $600,000 in gold as weighing approximately a short ton, then during 1908 over 20 tons of gold ($12,330,000) were produced. With this gold was mined 28 tons of tellurium, which was altogether a waste product. Since the beginning of the camp in 1891 about 320 tons of gold ($191,830,000) have been produced, with which was about 448 tons of tellurium. Smaller quantities are found in many mining camps of the West; but quantities more or less comparable with those mined at Cripple Creek are found in the slimes produced in the electrolytic copper refineries. In several of them the quantity of tellurium obtained in the slimes is known to be considerable, and a like condition probably exists at other electrolytic copper refineries. Both at Cripple Creek and at the refineries the tellurium could be easily saved; but no use is known for it, and there is no market.

Tellurium is supplied as a chemical curiosity in the form of a black powder and as a metallic appearing substance with a fine columnar crystal form, in color somewhat resembling tin. With arsenic and selenium it is classed as a metalloid.

Some of the organic compounds of tellurium have an offensive odor that permeates surrounding objects. Chemists[b] who have experimented with tellurium state that after three months' exposure to sun, wind, and rain the clothing worn during these experiments, although it had never come into direct contact with the substances upon which the chemists were working, still was so stinking that it had to be buried.

An electrical investigator in conversation with the writer stated that in certain experiments tellurium had shown a peculiar behavior toward electricity, which seemed to indicate that electrical uses might be found for the element, though none of the phenomena had been carefully studied.

[a] The geology and gold deposits of the Cripple Creek district, Colorado: Prof. Paper U. S. Geol. Survey No. 54, 1906.

[b] Baker, H. B., and Bennett, A. H., The atomic weight of tellurium: Jour. Chem. Soc., London, vols. 91 and 92, 1907, pp. 1849-1861.

When tellurides are heated on charcoal they give a white coating and color, the reducing flame green. When heated in a thin glass tube they give a white or grayish sublimate of tellurium dioxide, which may be fused to a pale yellow or colorless liquid. If finely powdered and heated with concentrated sulphuric acid tellurium gives a reddish violet color. Upon cooling and diluting the color disappears and a dark precipitate of tellurium will form.

TUNGSTEN, NICKEL, COBALT, ETC.

By Frank L. Hess.

TUNGSTEN.

INTRODUCTION.

By far the largest part of the tungsten produced each year is used in making tool steel. The market for tungsten, therefore, depends largely upon the steel trade, and when in 1907, along with other business, the steel industry suffered a great falling off, the demand for tungsten decreased greatly. Prices which during 1907 had reached $14 per unit for ore running 60 per cent or over of tungstic trioxide fell until there could hardly be said to be a real market in 1908. In many places men had started to develop tungsten deposits in 1907 and would have continued development even at low prices, but they had no market for their ores, and so were forced to stop work. In a number of cases large buyers bought ore for which they had no immediate use mostly to keep the miners, or part of them, in the tungsten fields, so that when the hoped-for greater activity came to the steel trade there would be men on hand to get out the tungsten ore which would then be needed. Although this was a far-sighted business policy, it was also generous, as firms paid to miners, with whom they had dealt for a considerable time, prices higher than those for which foreign ores could be bought.

It has been difficult for some producers to understand why the price of tungsten should have gone down with the slackening in the steel trade, because there has been a widespread belief, based upon frequently published statements, that most of the tungsten mined went into armor plate, and it was supposed that there was no cessation in the use of such steel by the United States and other governments. The writer has been informed by the Ordnance Bureau of the Navy Department that tungsten is not now, and, so far as known to that bureau, never has been used in the manufacture of armor plate in this country, and it is not known to have been so used in other countries, though it has probably been used in experimental armor plates. One of the greatest essentials of armor plate is its ability to resist shock, and this property is not imparted to steel by tungsten. Most armor plate depends for its shock-resisting properties upon the addition of nickel and chromium to the steel from which it is made and upon special treatment.

TUNGSTEN ORE INDUSTRY BY STATES.

South Dakota.—There was no production of tungsten ore in South Dakota during the year, but the Wasp No. 2 mine, about 2½ miles south of Lead, sold some ore that had been previously extracted. The ore is sandy dolomite impregnated with wolframite. At Hill City development work was prosecuted by the Wolf Tongue Mining

Company, which was formerly known at this place as the Black Metal Mining Company, on claims in which wolframite occurs with light-colored cassiterite and a very small amount of scheelite in quartz veins. The American Tungsten Company holds claims 3½ miles east of Hill City, on which wolframite occurs in quartz veins with a little scheelite, but no cassiterite. No work beyond assessment work was done during the year, although the company has its own mill upon the property. There are a considerable number of similar tungsten-bearing quartz veins in the region, but little has been done upon them.

Southeast of Hill City are tungsten claims upon which wolframite occurs in coarse pegmatite.

The Black Hills wolframite occurrences have been briefly described by the writer in Bulletin 380,[a] just issued by the United States Geological Survey.

Colorado.—Tungsten mining has so far been confined to Boulder County, although prospects have been reported from several other counties. The mines are situated near Nederland in a strip of country about 9 miles long and from 2 to 3 miles wide, running from southwest to northeast along Middle Boulder and North Boulder creeks, Nederland being near the southwestern end of the area. Close by are apparently related veins which carry gold, silver, vanadium (in roscoelite), molybdenum, and tellurium. The country rock is composed of schists and gneisses cut by granite, which is in turn cut by other intrusives. Tungsten occurs as ferberite (iron tungstate) in sheeted veins in the granite, which show many vugs lined with beautifully crystalized ferberite.

During the year the Cardinal Company and the Stein & Boericke Company combined as the Primos Mining Company, and this is probably the largest tungsten-mining company in the world. It controls the Conger and other properties and has a mill at which custom work is done.

The Wolf Tongue Mining Company owns a large number of claims in the Boulder County area and also runs a custom mill. Its mines are over 300 feet in depth, and the ore is reported to be as rich as nearer the surface.

The third large concern operating in the district, the Philip Bauer Company, which mined upon claims known as the Rogers group, has been succeeded by the former manager of the mines, Eugene Stevens, who also operates a mill.

There are many smaller operators, most, if not all, of whom have their ores concentrated by one of the mills mentioned.

Montana.—The only tungsten ore known to have been mined in Montana during 1908 was a lot of hübnerite from the Birdie mine near Butte. This mine was formerly worked for silver, and hübnerite is reported to occur in the same vein in shoots which carry the mineral in thin blades embedded in quartz. Some of the blades are yellowish and remarkably translucent.

At Jardine a brownish to amber-colored scheelite occurring in gray quartz has been mined in connection with gold in the mine of the Kimberly-Montana Mining Company, but no ore is known to have been taken out during 1908.

[a] Tin, tungsten, and tantalum deposits of South Dakota: Bull. U. S. Geol. Survey No. 380, 1909, pp. 131–163.

Idaho.—Scheelite of a light buff color is found at Wallace in the Golden Chest and Golden Winnie mines in connection with galena, pyrite, chalcopyrite, tetrahedrite, sphalerite, gold, and silver, in quartz veins cutting slates. In the latter mine barite occurs with the scheelite.

A small quantity of scheelite has been reported from the North Fork mining district northeast of Ketchum, but the occurrence does not seem to be of commercial value.

Alaska.—On Lost River in Seward Peninsula, about 110 miles northwest of Nome, on one of the tin claims, a lode is reported to have been discovered which "carries 30 per cent of wolframite through 3½ feet." Tin occurs on these claims in connection with greatly altered granite porphyry dikes which cut Silurian limestones and carry wolframite, scheelite, molybdenite, pyrite, and chalcopyrite, and it is presumed that the new find is in close connection with the older workings.

Near Nome scheelite is found in the gold placers on Glacier, Rock, Lindbloom, Boulder, Twin Mountain, and other creeks, though not in great quantity. The largest pebble seen weighed perhaps 2 or 2½ pounds. Most of the pieces are less than a half-inch in diameter.

On Nelson Brothers' claims, Bonanza Creek, at the eastern end of Norton Sound, scheelite is said to occur in quantities large enough to make it a nuisance in the sluice boxes. The country rocks at both Nome and Bonanza Creek are schists.

A specimen of hübnerite has been received from Deadwood Creek, below Switch Creek, near Circle, where it was obtained in the gold placers. It is said that hübnerite has been seen in quartz veins in the vicinity.

Washington.—Wolframite is found at Deer Trail, Stevens County, and has been mined in the past, but litigation is reported to have closed the mines, so that there was no production during 1908. Farther north in the same range of mountains, near Bissell, 12 miles west of Addy, other wolframite mines are reported. Wolframite also occurs near Loomis, Okanogan County. Small quantities of scheelite and wolframite have been found in connection with cassiterite in pegmatite at Silver Hill, near Spokane; and wolframite has been found in Whatcom County, near the Canadian boundary, 25 miles west of the Simalkameen River.

California.—The principal producing tungsten mine of California has been the Papoose mine of the Atolia Mining Company, at Atolia, 5 miles south of Randsburg, in San Bernardino County. The mineral is an almost white scheelite, which in color and general appearance much resembles coarsely crystalline limestone. It occurs in large lenses in a vein cutting a considerably weathered granite. The gangue is a peculiar quartz, which fractures like chalcedony. The company has a concentrating plant at which custom work is done. Water is bought from the Santa Fe Railway, which ships it in tank cars from the railroad wells at Hinckley, about 60 miles southeast.

Some production was obtained by lessees of the Par, Float Iron, and Toboggan claims. On these claims scheelite occurs accompanied by quartz and carbonates of lime and iron. Little was done on other tungsten claims of the district. Scheelite occurs in the Sidney mine with gold in quartz veins cutting schists, but has so far not been saved. Small veins of scheelite also occur in the Yellow Aster mine at Randsburg. The mine is situated in a complex of schists intruded by granites and granite porphyries.

An insignificant amount of scheelite is taken out of dry placers worked for gold, but at one time a paying quantity of residual scheelite pebbles was mined from the sands on the Papoose claim.

At Paris, between Atolia and Bakersfield, a small quantity of scheelite was mined during 1908 by the Tehachapi Mining Company.

Scheelite, with galena, gold, and silver, is reported from the Newsboy and Silver claims of the Pacific Reduction Company in the Shadow Mountain district, reached from Cima, San Bernardino County.

A number of other tungsten claims were reported from the vicinity of Cima, but no definite information concerning them is at hand. A specimen showing a remarkable intergrowth of wolframite and scheelite has been received from the Gold Copper Mining and Milling Company of the Clark district near Nipton. The sides of the vein have wolframite crystals embedded in quartz, while the middle of the vein is filled with gray scheelite into which the wolframite crystals extend. Some of the veins show wolframite but no scheelite. A number of tons of tungsten ore were reported to be on the dump. Near Barnwell the Sagamore Mining Company reported tungsten (wolframite?) on the Alpha claims in the New York mining district. Five miles from Barnwell are claims upon which hübnerite occurs with pyrite and chalcopyrite in comby quartz veins cutting granite. Eight miles east of Vontrigger, on the Searchlight branch of the Santa Fe Railway, hübnerite occurs in quartz veins cutting granite. Fifteen miles northwest of Victorville [a] small quantities of scheelite are found at the contact of schists and limestone. The occurrence is not of economic importance. Both wolframite and scheelite have been reported to occur at a point 15 miles north of Victorville, but a specimen of the supposed wolframite proved to be specular hematite in broad foliæ.

Hübnerite is reported from the Tin Mountains in Inyo County, 35 miles from Lida, Esmeralda County, Nev. Freight rates and scarcity of water preclude working the deposit. Wolframite has been found in Mariposa County, 12 miles north of Raymond, in a quartz vein cutting andalusite schists, but the quantity so far shown is unimportant. Granite occurs in the region, but was not seen within several miles of the wolframite locality.

Nevada.—Hübnerite occurs in quartz veins at Round Mountain on the property of the Round Mountain Monster Gold Mining Company. A small amount of concentrates was taken out in an experimental run in 1907, but there was no production during 1908.

Hübnerite is reported to occur in the Paradise Mountains, Nye County, 60 miles north of Tonopah in a quartz vein cutting granite. Specimens show small amounts of scheelite also. Gold, silver, copper, fluorite, biotite, and pyrite accompany the tungsten.

A scheelite deposit, occurring in metamorphosed limestone at its contact with granite was under course of development, 4 miles from Browns, Humboldt County, during the year. The scheelite occurs in small grains through the altered limestone accompanied by garnet and other metamorphic minerals.

Hübnerite occurs at Ellsworth, Nye County, 65 miles southwest of Austin in quartz veins cutting granite. The veins were worked for silver in the early sixties, and there are said to be large quantities of tailings at the mines which carry a considerable percentage of

[a] Private communication from Gordon Surr, San Bernardino, Cal.

hübnerite. Fluorite, biotite, and orthoclase occur with the hübnerite, and the ore is stated to carry $4 in gold per ton.

One and one-half miles from Oak Springs, between 40 and 45 miles north of Johnnie siding, a claim has been prospected which carries some scheelite accompanied by powellite (calcium molybdate). The powellite resulted from the alteration of molybdenite. The occurrence does not seem to be of commercial importance.

At Osceola deposits have been under development which consist of hübnerite-bearing quartz veins which reach 3 feet in width and cut granite porphyry of post-Carboniferous age. The ore is in shoots and is accompanied by small quantities of scheelite, fluorite, and pyrite. Gold and silver are shown by assay, but the amount is not sufficient for economical recovery. Some hübnerite, part of which is said to have been rich pieces of float ore, has been shipped, but there have been no shipments for several years. Ely, the nearest railroad point, is 45 miles away.

Arizona.—The principal tungsten deposits in Arizona are those located about 4 miles north of Dragoon, Cochise County. There are a great number of quartz veins which cut a rather coarse granite and carry hübnerite with small quantities of white to honey-yellow scheelite, and pyrite, chalcopyrite, and fluorspar. Some mining has been done on the veins by the Primos Chemical Company, of Primos, Pa., but a much larger production has been made from placers formed through the weathering and degradation of the country. Some placer hübnerite was produced in 1908.

Hübnerite is described as occurring under similar vein conditions at Arivaca, 72 miles south of Tucson, in the Guijas Mountains. The distance to railway transportation is so great that little has been done with the deposits. During 1908, however, a shipment of ore was made from the Tungsten No. 3 claim by J. L. and Chas. E. Udall.

Seven and one-half miles north of Nogales, near the Southern Pacific Railroad, are deposits of wolframite, the geology of which seems to be similar to that of the deposits near Dragoon. A small quantity of scheelite accompanies the wolframite. There has been little development work on the deposits, and only a small quantity of ore has been shipped.

In the Whetstone Mountains, about 12 miles south of Benson, wolframite occurs in peculiar segregations in a white granite and in a quartz vein cutting the granite. The wolframite appears to be an original constituent of the granite, just as hornblende or biotie occur in other granites. The Euclid Mining Company made a small production from the deposit, but work has ceased. The deposits are briefly described in Bulletin 380 of the Survey.[a]

Eighteen miles northeast of Yucca, Mohave County, wolframite occurs in quartz veins cutting a siliceous mica schist. No production is known to have been made.

For several years Williams and Pittman have been producing wolframite from deposits in the Aquarius Range, 12 miles east of the Big Sandy, 50 miles southeast of Kingman, and not far from Owens.

Several other tungsten-bearing localities are reported in the same general region, but nothing is definitely known of them.

Scheelite occurs with gold and silver in the Maudina mine, Old Hat district, Santa Catalina Mountains, Pinal County, northeast of

[a] Hess, Frank L., Note on a wolframite deposit in the Whetstone Mountains, Arizona: Bull. U. S. Geol. Survey No. 380, 1909, pp. 164–165.

Tucson. The gangue carries oxides of iron which will probably give place to sulphides at greater depth. Shipments of scheelite are made from time to time.

New Mexico.—The Wild Cat Leasing Company produces wolframite from the Homestake group of claims which are mined for gold and silver at White Oaks, Lincoln County.

Scheelite occurs in the mine of the Anderson-Apache Copper Company, Hachita, Grant County, but none has been produced commercially. Scheelite is also reported from the Daisy mine, 7 miles southeast of Hachita. The ores in this mine are carbonates carrying copper, gold, silver, and bismuth. The country rock is limestone at both mines.

In the Victorio district, 4 miles south of Gage, Luna County, on the Southern Pacific Railroad, a quartz vein from 1 to 5 feet thick intersects limestone and carries hübnerite accompanied by galena, pyrite, wulfenite, lead carbonate, and a little scheelite. There are no igneous outcrops in the vicinity. There has been some production.

Scheelite occurs with bismuth ores on claims on the east side of San Andreas Range, Socorro County, 37 miles west of Tularosa, and 3 miles north of the Dona Ana County line. A small quantity of ore has been mined.

PRODUCTION.

The production of tungsten ores in this country from year to year can be fairly compared in the following table only since and beginning with 1906, as before that date no effort had been made to reduce the ores to a common basis of concentration. Since 1906 the ores have been, as far as possible, reduced to an equivalent of ore carrying 60 per cent tungstic trioxide (WO_3), which is the ordinary commercial basis in the United States.

Owing to the lowering of the demand for tungsten, the production of the United States fell from 1,640 short tons of ore carrying 60 per cent of WO_3 in 1907 to 671 tons in 1908. Boulder County, Colo., still produced the bulk of the ore, but its output fell from 1,146 short tons of ore carrying 60 per cent of WO_3 in 1907, to 584 tons in 1908.

Production of concentrated tungsten ores in the United States, 1900–1908, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1900	46	$11,040	1905	803	$268,676
1901	179	27,720	1906	928	348,867
1902	184	34,040	1907	1,640	890,048
1903	292	43,639	1908	671	229,955
1904	740	184,000			

WORLD'S PRODUCTION.

In common with the falling off in the United States, the world's production of tungsten also was much less in 1908 than in 1907. It has not been possible to obtain complete figures for 1908, but returns from enough of the largest producers are at hand to show a great decline.

Wherever new data have become available the output for former years has been corrected, thus changing the totals as given in the report for 1907.

The world's production of tungsten ore, 1905–1908, by countries, estimated in short tons of concentrates containing 60 per cent of tungsten trioxide.

Country.	1905.	1906.	1907	1908.
Africa: South Africa	.....	9	211	[a] 27
Asia:				
Federated Malay States	.....	151	[b] 89	.....
Siam	.....	.....	[c] 10	.....
Australia:				
New South Wales	251	270	451	[d] 269
Northern Territory	71	230	177	[e] 9
Queensland	1,582	865	703	[f] 516
Tasmania	36	22	46	[g] 5
Victoria	.....	.....	.....	[h] 3
Western Australia	.....	.....	1	.....
East Indies:				
Billiton	.....	.....	4	[i] 11
Singkep	.....	.....	1	[j] 14
Europe:				
Austria	65	63	[k] 50	.....
England	193	304	361	[l] 261
France	28	20	[m] 67	.....
German Empire	42	57	[n] 68	.....
Italy	36	28	[o] 18	.....
Portugal	320	629	[p] 702	.....
Spain	413	222	[q] 303	.....
Oceania: New Zealand	64	121	153	[r] 87
North America: United States	803	928	1,640	671
South America:				
Argentina	.....	326	507	[s] 548
Bolivia	75	75	[t] 500	.....
Brazil	.....	.....	.....	[u] 16(?)
	3,979	4,320	6,062	.....

[a] Third annual statement of the trade and shipping of the colonies and territories forming the South African Customs Union, 1908, Cape Town, 1909, Ann. 42, p. 114. The percentage of tungsten trioxide in the ores is unknown.

[b] Letter from J. B. Scrivenor, Government Geologist, Federated Malay States, dated February 24, 1908. The output was from the States of Perak, Selangor, and Negri Sembilan. The percentage of tungstic trioxide is unknown.

[c] Letter from John H. Heyl, Act. Director Royal Dept. of Mines and Geology, Siam, dated March 11, 1908. Percentage of tungstic trioxide unobtainable.

[d] Letter from E. F. Pittman, Under Sec. for Mines, Sydney, May 3, 1909. The percentage of tungsten trioxide in the ores is unknown, but is believed to be high.

[e] Correspondence, Min. Jour., London, vol. 85, Jan. 20, 1909, p. 233. The percentage of tungsten trioxide in the ores is unknown.

[f] Queensland Govt. Min. Jour., vol. 10, 1909, p. 175. To 420.75 long tons of wolframite produced has been added half of a lot of 80 long tons of mixed bismuth and wolframite ores produced during the year. The percentage of tungsten trioxide in the ores is unknown.

[g] Progress of the mineral industry for quarters ending June 30 and December 31, 1908, Hobart, 1908 and 1909. Percentage of tungsten not given, but probably high.

[h] Letter from I. Cohen for Secretary for Mines, Melbourne, April 28, 1909. The percentage of tungstic trioxide in the ore is unknown.

[i] Letter from Mr. Regemann, Representative of the Billiton Maatschappij, Tandjong-Pandan, April 2, 1909.

[j] Letter from A. T. Ludwig, Mgr., Singkep Tin Maatschappij, March 27, 1909.

[k] Statistisches Jahrbuch des k. k. Ackerbau-Ministeriums für das Jahr 1907, Wien, 1908, Erste Lieferung, p. 90. Percentage of tungsten trioxide not given. Figures for 1908 unobtainable.

[l] Mines and quarries, general report with statistics for 1908. Home Office, London, 1909; pt. 4, p. 124, and pt. 1, 1908, p. 10. Percentage of tungstic trioxide contained is unknown, but much of it is reported to carry between 60 and 70 per cent, so that possibly 275 to 280 tons would be more nearly correct.

[m] Statistique de l'industrie minérale et des appareils à vapeur en France et en Algérie pour l'année 1907, Paris, 1908, p. 133. Percentage of WO_3 contained in ores unknown.

[n] Figures for Saxony only. Jahrbuch für das Berg-und Hüttenwesen im Konigreiche Sachsen, vom Jahre 1907, Freiberg, 1908, pp. 39, 55. Percentage of tungstic trioxide in ores not given. Figures for 1908 not obtainable.

[o] Rivista del servizio minerario nel 1907, Roma, 1908, p. 54. Percentage of tungstic trioxide in ores unknown. No production during 1908. (Letter from L'Ispettore Superiore Capo del corpo reale delle miniere, dated May 15, 1908.)

[p] Letter of J. F. N. Delgado, Director Roy. Geol. Survey Portugal, February 27, 1908.

[q] Letter from the Director of the Comisión del Mapa Geológico de España, Madrid, May 29, 1909. The apparently smaller output in 1906 than in 1905 is due to the reduction of the ores produced in 1906 to a 60 per cent basis, which was not done for the 1905 output. On the basis of the prices given these quantities have been reduced to 60 per cent on the supposition that the production in Cordoba, Coruna, and Pontevedra was all of about the same content, 25 per cent; Orense and Salamanca, 40 per cent; and Caceres, 60 per cent. Figures for 1908 not available.

[r] Letter from J. M. Bell, Director, New Zealand Geol. Survey, April 30, 1909. The mineral is all scheelite.

[s] Letter from E. Hermitte, Ministerio de Agricultura, División de Minas, Geología é Hidrología, April 1, 1908. Most of the ore went to Germany, a little to France.

[t] Smith, Ramsay. Bolivia. Report for the year 1907 on the trade of Bolivia. Diplomatic and Consular Reports No. 4128, Annual series, London, 1908, p. 25. The figures are based upon this paragraph:

"About 45 tons of wolfram was exported monthly for the first nine months of the year, giving a ley of about 65 to 70 per cent of tungstic acid. Most of it has been shipped to Hamburg. With the fall in price this export ceased. There seems to be an abundant supply of that ore, but it is situated somewhat distant from the railways."

[u] Letter from Orville A. Derby, Chefe de Serviço Geologico e Mineralogico do Brasil, June 2, 1909. Doctor Derby states that a shipment of this quantity from the State of Rio Grande do Sul was probably wolframite, though there is some doubt about it; some wolframite, however, was shipped from that State during 1908,

PROBABLE FUTURE PRODUCTION OF TUNGSTEN.

Concerning the probable future output of tungsten ores, generalizations only can be made. Tungsten deposits are usually "pockety;" that is, the ores occur in lenticular masses or small shoots in veins. Those occurring at the surface are often quickly and easily mined, and it may then require all of the profits made from the first-exposed ore body to locate another one. However, the veins carrying tungsten minerals appear to be of deep-seated origin, and, generally speaking, other ore bodies will probably be found in depth, though just as in mining for other minerals the expense of search may be out of proportion to the size of the pay shoots.

Queensland is a country in which the deposits exposed on the surface have been largely exploited, and the production, in the face of rising prices, fell greatly from 1905 to 1907. A further decrease was to be expected in 1908, owing to the great drop in prices. In England, Spain, Austria, Germany, Bolivia, and the Dutch East Indies, tungsten and tin ores occur together, and the working costs are thus lowered. Magnetic separators have increased the production of tungsten ores in England and are responsible for nearly the whole output of that country. In these countries it is probable that production will not decrease proportionately with prices, as tungsten minerals, if over 1 per cent of the concentrates, must be separated from the tin ores to make the latter salable and when so separated the sale of the tungsten ores makes an additional profit for the mine.

The occurrence of tungsten is wide, but the individual deposits can hardly be said to be large. In times of high prices there are many deposits which can be worked that will be idle at lower prices, and it is probable that there will be something of a revival of prices and consequently of production in 1909 to accompany a probable expansion of steel production in the United States and other countries.

TUNGSTEN MINERALS.

The tungsten minerals used as ores are hübnerite, a tungstate of manganese; wolframite, a tungstate of manganese and iron; ferberite, a tungstate of iron; and scheelite, a tungstate of calcium. The first three minerals grade into each other, and wolframite is a good class name to use for the three until the particular species may be determined. In general, hübnerite has a semitranslucent appearance which, as in that from the Birdie mine at Butte, approaches transparency in certain specimens. Wolframite shows little or no translucency and is nearly black. Ferberite is black and opaque, and shows a tendency to form in small crystals with chisel-shaped terminations. As the iron content increases in tungsten minerals the streak becomes progressively darker, from light yellow in some hübnerite to deep brown in ferberite.

Scheelite is calcium tungstate, a combination of lime and tungsten trioxide. In appearance it varies from an almost glassy white to a dull brown or yellow, and is occasionally of a slight greenish tinge. It is always of a stony appearance, some specimens resembling coarse marble in structure. In places it shows its crystal form, which is tetragonal. It has a specific gravity of 6, or about twice that of limestone or quartz, and its weight at once attracts attention. It is somewhat softer than limestone and is easily scratched with a knife.

The only other minerals which are liable to be confused with it are barite, which is softer and not so heavy, having a specific gravity of 4 to 4.5, and quartz, which has a comparatively low specific gravity (2.65) and can not be scratched with a knife. Scheelite has an almost greasy, lustrous appearance when broken; the appearance of barite is often dull, and quartz has a more splintery, glassy fracture.

The tungsten minerals, like tin ore, generally occur in veins cutting igneous rocks containing much silica, such as granite and granodiorite. Sometimes the veins penetrate rocks lying adjacent to the igneous rocks. Apparent exceptions to this rule are found, as, for instance, in the Victorio district, 4 miles south of Gage, N. Mex., where hübnerite and some scheelite occur with pyrite and lead minerals in a vein cutting limestone; and at Nome, Alaska, where scheelite is found in the gold placers in a region of schists, several miles from the nearest granite outcrop. However, in general, search for tungsten may be expected to be most successful in districts of granitic rocks.

TESTS FOR TUNGSTEN MINERALS.

Materials required for tests.—Owing to the number of inquiries received concerning the identification of tungsten ores, it seems advisable to give a description of simple tests which have been found reliable by the writer.

The tests which are herein given are such as can be made by any prospector who can obtain hydrochloric (muriatic) acid, a test tube, a teacup or a drinking glass, and either a little tin foil, a piece of zinc, a bit of solder, or a scrap from an ordinary tin can. A few test tubes and an alcohol lamp are not expensive and add much to the convenience of testing. In testing the minerals it is well to heat the cup or glass to get prompt and energetic action from the acid.

Unless the suspected mineral is present in quantity, the material to be tested should be concentrated by panning or careful selection. Owing to the high specific gravity of tungsten minerals, they are easily concentrated by panning.

Scheelite.—To test scheelite place a portion of the powdered mineral the size of a pea in a test tube or a cup and cover with about a teaspoonful of hydrochloric acid. After the liquid has been boiled a few minutes or, if not heated, after it has stood a considerable time, tungsten trioxide (WO_3), a bright-yellow powder, is formed. Upon the addition of metallic tin or zinc the yellow powder is reduced to a lower oxide, which is of a characteristic beautiful blue color, and later to still lower oxides of other colors.

With zinc the solution first turns blue, then wine-colored, and later brown. When the reduction takes place very quickly the blue color of the solution may not be seen at all, the first color to appear being a reddish lilac, quickly turning to brown.

With tin the solution turns successively blue, lilac, wine-colored, and more slowly to brown. The wine color may last for hours. Tin foil, which is ordinarily composed largely of tin with varying quantities of lead, may be used. In the reduction with tin the solution nearest the tin will often have a lilac or wine color, while a short distance away the solution will be a fine blue.

With either zinc or tin the powdered mineral itself will be colored blue, even though the solution may be of a different color. When treated with acid several minutes should be allowed to elapse before introducing zinc or tin; otherwise the yellow oxide may not be

formed in sufficient amount to give a good reaction, and neither the blue nor the pink color will be seen, but the solution will be a yellowish brown. However, a blue sediment will form in the bottom of the vessel. If one part of hydrochloric acid diluted with two parts of water be used, tin gives to the solution a blue color which lasts a considerable time.

Sulphuric acid diluted with two or three parts of water to one of acid may be used instead of hydrochloric acid, and seems to be the more active of the two in changing scheelite to tungsten trioxide. It is slower than hydrochloric acid in reducing the yellow oxide to the blue oxide upon the addition of zinc and needs more heating, but it gives the same blue color, which is more lasting and may still show after standing twenty-four hours.

With tin, sulphuric acid acts still more slowly and requires considerable heating, but gives the blue color. Nitric acid gives the yellow tungsten trioxide, but will not give the further reactions.

Wolframite.—In testing wolframite the mineral should be finely powdered, then heated or boiled with hydrochloric acid for from ten to twenty minutes before treatment with zinc or tin. Otherwise, owing to the difficulty of digestion in acid, no reaction will be seen. The same phenomena will appear upon treatment with zinc or tin as in the case of scheelite.

The mineral may be tested much more certainly and easily by powdering a small portion, mixing intimately with ordinary baking soda, and fusing in an iron spoon or on a piece of sheet iron inserted in the end of a split stick. If well fused, the presence of manganese will be shown by the green color of the mass. Even should the fire not be hot enough for entire fusion, the test will be made much easier by the mere caking of the material. After thus heating with soda the mass is treated with acid and reduced with zinc or tin, as described under scheelite, and gives the same reactions.

No elements which interfere with the tests suggested are known to occur with tungsten ores.

USES OF TUNGSTEN.

The uses to which tungsten is put are now fairly well known. The most important use, and the one which makes tungsten mining on an extensive scale possible, is as an alloy for tool steel. The introduction of tungsten into such steel gives it the property of holding its temper at a much higher temperature than high-carbon steels. Thus, when lathe tools are made from tungsten steel the lathes may be speeded up until the chips leaving the tool are so hot that they turn blue. It is said that about five times as much work can be done by a lathe built for such speeds and work and fitted with tungsten-steel tools as can be done by the same lathe with carbon-steel tools. Sixteen to 20 per cent of tungsten is ordinarily used in lathe tools. In saws 1½ to 3½ per cent of tungsten is used by some makers. In hacksaws larger percentages of tungsten are used. As stated in the first portion of this paper, tungsten is not known to be used in armor plate, though often so reported.

C. A. Edwards[a] states that a steel containing carbon 0.68 per cent, chromium, 3.01 per cent, tungsten 19.37 per cent, and silicon 0.04

[a] Function of chromium and tungsten in high-speed steel: A paper delivered before the Iron and Steel Institute and quoted in Mech. Engineer, Manchester, vol. 21, 1908, p. 723.

per cent was the hardest steel which, so far as he was aware, had been recorded. The Brinnel ball test gave it a figure of 866.

The melting point of tungsten is exceedingly high, about 3,080° C., so that when reduced to a metal it is obtained, not as a solid, but as a very fine gray powder, and it has so far been found impossible to fuse greater than filamentary masses of tungsten into solid form. When used in steel, tungsten is introduced into the crucibles either as metal or as ferrotungsten. Owing to the finely divided condition of metallic tungsten, some steel makers consider that a large proportion is lost through oxidation and in the slag, so that it is used by them in the form of ferrotungsten, an alloy of iron and tungsten containing from 40 to 82 per cent of tungsten. As tungsten has a specific gravity of 19.26, lumps of ferrotungsten remain immersed in the molten steel until dissolved.

The high temperature at which tungsten fuses makes it available for use as a filament in incandescent electric lamps, and such lamps are rapidly coming into common use. The whiteness of the light makes it far superior to that of carbon incandescent lamps. The efficiency of the tungsten filament lamp is remarkably high, about 1¼ watts per candle, as compared with 3.1 watts per candle for the ordinary carbon lamp, 2.5 watts per candle for the Gem metallized filament lamp, and 2 watts per candle for the tantalum filament lamp. The great drawback to the use of the lamps is that the filament is very brittle and the loss in shipment is large. The life of the tungsten-filament lamp is fully twice that of a carbon lamp, and it can be used on either alternating or direct current. The specific resistance of tungsten is low, so that for ordinary voltages such as are used on city lighting circuits the filament must be long, and is made in several "hairpin" loops, unless lighted in series. Thousands of filaments can be made from a pound of tungsten, so that the market for tungsten ores for this use is very small. Metallic tungsten has been tried for arc lamp electrodes, but has not proved a success.

Tungsten is used in the manufacture of small crucibles for use in the electric furnace. These are made by mixing tungsten powder with a small amount of some carbonaceous paste and pressing the mixture into the desired shape, after which it is sintered in an electric furnace. This makes a porous metallic vessel as the particles will not melt sufficiently to run together. The crucibles when used are lined with an inert, infusible substance, such as thoria, for, when heated, tungsten combines readily with many substances.

Large quantities of sodium tungstate are manufactured, much of which is said to be used in fireproofing cloth for curtains, draperies, etc., and as a mordant in dyeing. Other tungsten salts are used in weighting silks. When silks are dyed, tungsten salts, owing to their high specific gravity, are introduced to give more apparent weight to the fabric. Sodium tungstate has almost precisely the same rate of expansion for moderate temperatures as platinum, so that it is used for sealing platinum apparatus in making water determinations in chemical analyses of rocks.

Calcium tungstate is used as a screen to make X rays visible. Tungsten salts are also said to be used in glass making, and in making gold and violet bronze powder.

BIBLIOGRAPHY.

This bibliography gives some of the more prominent articles upon tungsten occurrences.

AUERBACH, HERBERT S. Tungsten ore deposits of the Cœur d'Alenes: Eng. and Min. Jour., vol. 86, 1908, pp. 1146–1148, 6 figs.

Scheelite was here first found in the gold placers of the region. A large shoot of scheelite in the Golden Chest mine at Murray is described. The country rock is slate and quartzite. The scheelite and gold are thought to have accompanied an intrusion of syenite. Quartz, iron pyrites, and some free gold accompany the scheelite. In the Golden Winnie mine barite accompanies the scheelite. Gives chemical tests, milling and metallurgical processes, and uses for tungsten.

Anon. Tungsten mining in California: Eng. and Min. Jour., vol. 86, p. 573.

A description of the Papoose mine at Atolia, Cal., by a writer who has not been in the mine.

Anon. Tungsten: The Mineral Industry, New York and London, yearly.

Gives market conditions and epitome of many of the important occurrences of the world.

Anon. Wolfram mining in North Queensland: Queensland Govt. Min. Jour., vol. 9, 1908, p. 226, 4 pl.

Mr. Dunstan, the government geologist, is quoted as estimating the tungsten-bearing area of North Queensland to extend over 3,500 square miles. The Irvinebank Company has ores carrying a mixture of wolframite, molybdenite, and bismuth at its mines, which are extensive.

BECK, R. Über ein kürzlich aufgeschlossenes Wolframerzgangfeld und einige andere neue Aufschlüsse in sachsischen Wolframerzgruben. Zeitschr. prakt. Geologie, vol. 15, 1907, pp. 37–45, 9 figs.

Exploitation of wolframite began in Tirpersdorf in 1906. Three veins, largest 13 inches thick. Very little manganese in ore, which is well crystallized, crystals reaching 4 inches in thickness. Some molybdenum occurs with it. At Sadisdorf small amounts have been mined. Deposits compared with those at Deer Trail, Wash. The Zinnwald mines in which tungsten ore occurs with tin ore averaged 37 tons of tungsten ore annually from 1895 to 1905. A new mine near the Bohemian frontier yielded 12 tons of wolframite in 1905 from a vein 18 inches thick at the contact of granite and quartz porphry. The wolframite veins are probably later than the tin veins.

BLAKE, WM. P. Wolframite in Arizona: Eng. and Min. Jour., vol. 65, 1898, p. 608.

Announces the discovery of hübnerite at Dragoon, Ariz., and gives a short description of the occurrence.

——— Hübnerite in Arizona: Trans. Am. Inst. Min. Eng., vol. 28, 1898, pp. 543–546; 1 fig.

Describes the occurrence of hübnerite near Dragoon, Ariz., in quartz veins cutting granite. Considers the veins to be of the segregation type. Notes the presence of scheelite and fluorite, but no sulphides. A carload of ore was concentrated at the Arizona School of Mines, giving excellent results.

BOGENRIEDER, CHARLES. Wolfram ores—occurrences and uses. Their importance in Australia and to commerce in general: Australian Min. Stand., vol. 40, pp. 557, 609, 636, 664, 693, 722, 723, 745, 746.

Gives a short history of the knowledge of tungsten minerals; descriptions and analyses of the known tungsten-bearing minerals; a list of localities where tungsten minerals are found, and, in places, an epitome of the geology; the metallurgy of tungsten; uses in alloys; chemistry of tungsten compounds.

CARNE, J. E. Notes on the occurrence of tungsten ores in New South Wales, with a register of localities: New South Wales Geological Survey, Mineral Resources No. 2, Sydney, 1898, pp. 8.

Epitomizes the world's production of tungsten ores; the uses of tungsten; the qualities demanded of ores; and a list of the places in New South Wales at which tungsten ores have been found, with brief notes upon the localities.

CHERRY, F. J. Mining for wolfram and copper on Noble Island: Queensland Govt. Min. Jour., vol. 9, 1908, p. 263.

Noble Island is 80 miles north of Cooktown, Queensland, and 5 miles from the coast. A small amount of wolframite is taken from the outcrops of quartz veins, which seem to cut sandstones. The island, though small, also carries tin, gold, silver, and copper ores.

FERMOR, L. LEIGH. Note on an occurrence of wolfram in Nagpur district, Central Provinces: Records Geol. Survey India, vol. 36, part 4, 1908, pp. 301–311.

Notes the discovery by an American of wolframite irregularly distributed in quartz veins interbedded with mica and tourmaline schists. No production has so far been made.

GOODALE, C. W. and ACKERS, WILLIAM A. Concentration before amalgamation for low-grade, partially decomposed, silver ores, with notes on the geology of the Flint Creek Mining District: Trans. Am. Inst. Min. Eng., vol. 18, p. 248.

Mentions the occurrence of hübnerite with pseudomalachite (phosphate of copper) in the silver-bearing vein of the Combination mine at Philipsburg, Mont.

GREENAWALT, WM. E. The tungsten deposits of Boulder County, Colo.: Eng. and Min. Jour., vol 83, 1907, pp. 951–952, 1 fig.

Gives a short history of tungsten mining in Boulder County; the extent of the district; geology; ore treatment and manner of purchasing ore. Thinks the ore may extend south into Gilpin County. Calls the ore wolframite, but gives analyses showing it to be ferberite. Ore is always brecciated feldspar carrying tungsten; feldspar sometimes replaced by quartz. Says ore occurs with andesite dikes in a country rock of schist and granite. Many ore bodies do not outcrop, but are located by a black manganese stain at the surface.

GURLT, ADOLF. On a remarkable deposit of wolfram ore in the United States: Trans. Am. Inst. Min. Eng., vol. 22, 1893, pp. 236–242.

Describes the occurrence of wolframite in pseudomorphs after scheelite at the contact of gneiss and marble in Trumbull Township, Conn. The occurrence is connected with acid dikes carrying topaz, beryl, euclase, bismuth, and minerals which ordinarily accompany cassiterite.

HESS, FRANK L. Note on a tungsten-bearing vein near Raymond, Cal.: Bull. U. S. Geol. Survey No. 340, 1908, p. 271.

Brief description of a wolframite-bearing quartz vein which cuts andalusite mica schist near Raymond, Cal. Pyrite is an accessory mineral. The deposit is unimportant.

——— Tin, tungsten, and tantalum deposits of South Dakota: Bull. U. S. Geol. Survey No. 380, 1909, pp. 131–163.

Tungsten occurs in the Black Hills of South Dakota, almost wholly in the form of wolframite. Scheelite occurs, so far as known, only in small quantity. The wolframite occurs near Hill City, in a few places, in coarse pegmatites as an original constituent; in more places it occurs in quartz veins which are probably a later phase of the phenomena which caused the pegmatites. In some veins it is accompanied by light-colored cassiterite with which it is intergrown. Prospecting is being carried on with promise of an output. At Lead, wolframite occurs in replacement deposits in a sandy dolomite with barite, gold, pyrite, glauconite, etc.

IRVING, J. D. Some recently exploited deposits of wolframite in the Black Hills of South Dakota: Trans. Am. Inst. Min. Eng., vol 31, 1901, pp. 683–695.

Wolframite occurs near Lead, S. Dak., in the Two Strike, Wasp No. 2, Little Pittsburg, and other mines, as replacement deposits in flat sandy Cambrian dolomites. The wolframite is fine grained and resembles iron ore in appearance. It is accompanied by scheelite (in small quantity) barite, quartz, stibnite, pyrite, fluorite, jarosite, and gypsum.

JOHNSON, J. P. The ore deposits of South Africa, part 1, Base Metals, London, 1908, p. 40.

Brief description of the Richardson mine at Essexvale, near Bulawayo, and of the Scheelite-King mine near the Umswege River, on the Gatuma side of the Hartley district, South Africa. In the former mine wolframite with a little scheelite occurs with chlorite, quartz, tourmaline, fluorite, and topaz as an impregnation in fine-grained granite. In the latter mine scheelite occurs in a quartz vein in schistose granite, which is much epidotized near the vein.

KELLOGG, L. O. Sketch of the geology and ore deposits of the Cochise mining district, Cochise County, Ariz.: Econ. Geology, vol. 1, 1906, pp. 654–655.

Brief description of the hübnerite-bearing quartz veins near Dragoon, Ariz.

LINDGREN, WALDEMAR. Some gold and tungsten deposits of Boulder County, Colo.: Econ. Geology, vol. 2, 1907, pp. 453–463.

The Boulder County gold and tungsten deposits, though not occurring together, are an extension of the Clear Creek-Gilpin ore belt. The tungsten mineral, here called wolframite, though later analyses show it to be ferberite, occurs in brecciated, or shear, zones in granite. There are many vugs in which the ferberite shows crystal terminations, and some are filled with a kaolin-like substance. A little molybdenite probably occurs with the ferberite, and there is some pyrite. Besides quartz no other visible vein mineral is present, though assays show small quantities of gold and silver. The tungsten veins are related to gold and silver veins of the district, which carry roscoelite and tellurides of gold and silver.

Lovisato, Domenico. Giacimento di minerali di tungsteno a Genna Gurèu ai limiti fra Murri ed Orroli (Cagliari): Atti della Reale accademia dei Lincei, ser. 5, vol. 16, 1907, pp. 632–638. Digest translation, Trans. Inst. Min. Eng., Newcastle-upon-Tyne, vol. 33, 1908, pp. 686–687.

Scheelite is found in veins worked for antimony at Genna Gurèu. The country rocks are argillaceous, micaceous, and occasionally talcose schists cut by many quartz veins. The scheelite is crystalline, pink, white, yellow, or gray, and is in some places altered to meymacite.

McCallum, A. L. An interesting occurrence of scheelite in Nova Scotia: Canadian Min. Jour., vol. 29, 1908, p. 456.

Notes the discovery of a scheelite nodule, partly altered to tungstite, at Moose River, Nova Scotia, and the later finding of five scheelite-bearing quartz veins. One vein is in a narrow slate belt in whin (basalt), and carries arsenopyrite. The scheelite is in lenses from 7 inches downward and averages about 3 inches (thick?). Gives analyses.

Pearce, Richard. The association of minerals in the Gagnon vein, Butte City, Mont. Trans. Am. Inst. Min. Eng., vol. 16, 1888, p. 64.

States that hübnerite is found in the Gagnon vein with silver and copper-bearing sphalerite, silver-bearing pyrite, wurtzite, copper minerals, etc.

Pittman, E. F. The mineral resources of New South Wales: New South Wales Geol. Survey, Sydney, 1901, pp. 294–303.

States that wolframite, scheelite, and stolzite are found in New South Wales. Quotes a general article upon tungsten from "Mineral Industry for 1893." Gives the list of occurrences in New South Wales from Carne (vide this bibliography), somewhat rewritten, and also gives the output of tungsten ores in the State from 1891 to 1899.

Playford, E. Copley. Goldfields and mining—Chief Warden's report: Government Resident's Report on the Northern Territory, 1907, Adelaide, 1908, pp. 28, 30, 31, and 41.

Gives a few particulars of tungsten mining on Wolfram Creek and at Wolfram Camp, Northern Territory. Wolframite is said to occur with copper ores in pipes.

Preus, Wilhelm. The Panasqueira tungsten district, Portugal: Eng. and Min. Jour., vol. 83, 1907, p. 843, 1 map.

The Panasqueira tungsten mines are in the province of Beira Baixa, Portugal, divided into the Panasqueira and Cabeco Piao groups. They are 11 kilometers from the nearest igneous outcrop. Wolframite, accompanied by cassiterite, oxide of iron, pyrite, mispickel, and mica, occurs in "quartz beds," dipping from 5° to 35° in Cambrian schists. The mineralization is erratic, and bunches of ore occur where faults cross each other. The Panasqueira field has been worked for ten years, and there are 15 proved beds from which have been sold 600 tons (68–71 per cent WO_3) of wolframite laid down at Fundao for $130 per ton. Ten beds have been proved in the Cabeco Piao group, from which 68–71 per cent WO_3 ore can be extracted at from $80 to $100 per metric ton.

Richards, Ralph W. The Dragoon, Ariz., tungsten deposits: Min. Sci., vol. 57, 1908, pp. 93–94.

Hübnerite and scheelite, the latter in small quantity, occur in quartz veins cutting a coarse porphyritic granite at Russellville, 4 miles north of Dragoon, Ariz. Most of the ore mined has been taken from placers. Disagrees with Forbes Rickard as to the geology and mineralogy.

Rickard, Forbes. Notes on tungsten deposits in Arizona: Eng. and Min. Jour., vol. 78, 1904, pp. 263–265.

Describes the geology, mining, history, and marketing of ores from the hübnerite deposits at Dragoon, Ariz. The geology is inexact.

Ries, Heinrich. Economic geology of the United States: New York, 1905, pp. 414–416.

A short and incomplete account of occurrences and uses of tungsten.

Simpson, Edward S., and Gibson, Chas. G. The distribution and occurrence of the baser metals in Western Australia: Bull. Western Australia Geol. Survey No. 30, Perth, 1907, pp. 155–117.

Wolframite has been found in Western Australia at a number of places, but at none in paying quantities. At Ravensthorpe in 1907 22 hundredweight of concentrates from a gold property assayed "66.2 per cent of tungstic acid." This is the only output of wolframite known in the State. Scheelite occurs at a number of mines with gold, and carries coarse gold at the Lindsay mine, Coolgardie. Large masses occur in quartz in the Sons-of-Erin gold mine at Higginsville.

SMITH, F. B. The Osceola, Nev., tungsten deposits: Eng. and Min. Jour., vol. 73, 1902, pp. 304–305. 1 plate.

Gives a more detailed account than the previous article by Weeks of the Osceol hübnerite deposit. States that fluorite and pyrite accompany the tungsten minerals and that assays of both pyrite and hübnerite give over 2 ounces of silver per ton, with a trace of gold.

SURR, GORDON. Tungsten near Randsburg: Am. Min. Rev., Los Angeles, vol. 22, Nov. 9, 1907, pp. 7–8.

Lists the gold mines in the vicinity of Randsburg which carry scheelite, and gives a hearsay description of the Papoose mine at Atolia.

——— Tungsten in Arizona: Am. Min. Rev., Los Angeles, vol. 22, Nov. 23, 1907, pp. 8–9, 1 fig.

A popular account of the hübnerite deposits north of Dragoon, Ariz.

——— Genesis of tungsten: Am. Min. Rev., Los Angeles, vol. 23, Feb. 1, pp. 8–9; Feb. 8, pp. 7–8; and Feb. 15, 1908, p. 8.

Explains the deposition of tungsten ore by magmatic waters and the formation of tungsten placers through disintegration and denudation of the barren country rock.

——— A new tungsten find: Am. Min. Rev., Los Angeles, vol. 23, March 7, 1908, p. 9.

Describes a hübnerite deposit 7 or 8 miles east of Vontrigger, near Goffs, San Bernardino County, Cal. It is in quartz veins cutting granite, and the veins reach 3 feet in width. The quartz shows crystals, and there is some copper staining in the vein.

——— Tungsten at Victorville: Am. Min. Rev., vol. 24, July 11, 1908, pp. 8–9.

Describes an economically unimportant occurrence of scheelite, 15 miles northwest of Victorville, San Bernardino County, Cal. Scheelite, with copper minerals, occurs in altered limestone at its contact with schists. Pegmatite dikes cut the schists close by.

——— Tungsten deposits and surface enrichment: Min. World, vol. 30, 1909, p. 19.

Describes the deposition of tungsten ores from magmatic waters, and thinks the apparent greater richness of tungsten ores near the surface may be due to their having been deposited within narrow limits of depth. Considers secondary concentration also to be a possible explanation.

THYNG, W. S. Tungsten deposits in Washington: Eng. and Min. Jour., vol. 73, 1902, p. 418.

Describes briefly an occurrence of wolframite in a quartz vein cutting granite in Stevens County, Wash. (the locality now known as Deer Trail—F. L. H.). The claim had been worked for gold and silver and abandoned. The wolframite was supposed to be merely an iron mineral.

TOMEK, F. Tungsten in Montana: Min. World, vol. 28, 1908, p. 63.

Gives a short description of the Birdie silver mine, 4 miles east of Butte, which contains a shoot of hübnerite, 12 to 20 inches thick, 3 to 5 feet wide, and 20 feet long, as developed.

TWELVETREES, W. H. Report on the Bell Mount and Middlesex district (Tasmania), Tasmania Geol. Survey Report, Hobart, 1907, pp. 1–30.

At the Shepherd and Murphy mine, on Bismuth Creek, a tin-tungsten-bismuth vein occurs in a wollastonite-epidote rock, evidently altered limestone, which also contains vesuvianite, diopside, and garnet. Granite or quartz porphyry are supposed to exist close at hand. Topaz occurs in the vein with quartz. The vein cuts Middle Silurian rocks. Also mentions quartz bismuth-tungsten veins at All Nations mine; tin-bearing stock works in granite and quartz porphyry; alluvial deposits of gold, tin, and tungsten; and veins of pyrite, galena, molybdenite, cupriferous quartz, gold and silver in the same district. Spodumene is found in one of the veins. In All Nations mine wolframite occurs with some molybdenite, bismuth carbonate, gold, and silver. No tin is found in this vein. There are a number of small veins carrying tin and tungsten, and tungsten and molybdenite.

WALKER, F. L. The occurrence of tungsten ores in Canada: Jour. Can. Min. Inst., vol. 11, 1908, pp. 367–371.

Briefly describes the occurrence of scheelite in Yukon placer concentrates; in a tin deposit, with hübnerite and wolframite, at New Ross, Lunenberg County, Nova Scotia; in vein quartz in the Meteor mine, Slocan district; in the country rock and in quartz veins, and in placers on Hardscrabble Creek, Caribou district, British Columbia; with concretionary tungstite carrying visible gold in the Kootenay Belle mine, Sheep Creek, British Columbia; and in small fragments at the Victoria nickel mine, Sudbury district, Ontario. Gold-bearing quartz veins on Sheep Creek near Salmo, British Columbia, carry a considerable percentage of wolframite and a little tungstite. A number of analyses are given.

WEEKS, F. B. An occurrence of tungsten ore in eastern Nevada: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 6, 1901, pp. 319–320.

Describes briefly an occurrence of hübnerite in the Snake Mountains, 12 miles south of Osceola, Nev., and 100 miles from a railroad. Hübnerite occurs in quartz veins reaching 3 feet thick, cutting a hornblende-mica granite. Some scheelite accompanies the hübnerite. Assays show some gold.

——— Tungsten deposits in the Snake Range, White Pine County, eastern Nevada: Bull. U. S. Geol. Survey No. 340, 1908, pp. 263–270. 1 map.

Another description of the Osceola deposits, with more detail, and the developments which had taken place since his former visit. Osceola now 45 miles from railroad. Considers the possibilities of power obtained from a stream.

NICKEL.

Nickel was mined and smelted by the North American Lead Company, at Fredericktown, Mo., during 1908; one lot of ore was shipped by the Nevada Nickel and Copper Company from the Key West mine, Bunkerville, Lincoln County, Nev., to the former company for treatment; and some nickel salts were made by the United States Metals Refining Company at its Chrome (N. J.) refinery from electrolyte solutions obtained in the refining of copper.

The ore of the North American Lead Company "consists of an intimate mixture of the sulphides of copper, lead, nickel, and cobalt, and iron in the form of chalcopyrite, galena, linnæite, and pyrite. The lead, as far as possible, is removed in concentration, the iron is removed by roasting and magnetic separation, and the resulting concentrate is smelted."[a] The company has not yet reached the output aimed at. Its ore bodies are claimed to be extensive and the possibilities of production large.

Several hundred tons of concentrates similar to those smelted by the North American Lead Company lie on the land of the Hudson Valley Lead Company. This company mines ores which are like those of the former company, but does not smelt them. Certain areas of the Mine La Motte Lead and Smelting Company's mine also carry copper-nickel-cobalt sulphides. The company formerly smelted these ores to matte, but now smelts only lead ore. This mine is extensive, having been worked for lead since 1720.

The Nevada Nickel and Copper Company, at Bunkerville, Nev., has carried on prospecting and development work for a number of years, and has done a large amount of underground work. The mine is a long distance from the railroad, the nearest point being Moapa, on the San Pedro, Los Angeles and Salt Lake Railroad, 40 miles away. Assays of the ore show the presence of platinum, gold, silver, nickel, and copper. Cobalt is not mentioned.

At the Chrome (N. J.) refinery copper from the Sudbury, Ontario, nickel deposits is refined with copper from many other sources, and it can not be told what proportion of the small output is strictly American. However, nickel is also found in the copper in other refineries, though no others are known to have made a saving.

In the refining of copper by electrolysis nickel contained in the raw copper anodes goes into solution in the electrolyte, and unless the solutions are changed before the nickel forms 1 per cent of the solution nickel deposits with the copper. It is said that this causes the copper to lose some of its toughness; and before this was found to be a serious factor in electrolytic refining it was impossible to make electrolytic copper equal to the best Lake Superior brands, but

[a] Siebenthal, C. E., Mineral Resources U. S. for 1907, pt. 1, U. S. Geol. Survey, 1908, p. 541.

refiners claim that since this discovery electrolytic copper is made equal to any other and even superior in electro-conductivity.

Assessment work only was reported from the nickel deposits at Blackbird, Idaho, which are at present over 100 miles from a railroad.

Nothing of moment is known to have been done at the nickel prospects near Lovelocks, Nev., Riddles, Oreg., Keller, Wash., or Webster, N. C. The Lancaster County Nickel Corporation did some prospecting in Bart Township, Lancaster County, Pa., on property adjoining on the southeast the old Gap Nickel mine.

No easy field test for nickel is known. The ordinary uses for the metal are well known, but recently the Orford Copper Company has put on the market, under the name of "monel metal," an alloy which contains 68 per cent of nickel, 1.5 per cent of iron, and 30.5 per cent of copper. This alloy is made by extracting the nickel and copper from the ore without separating them, which makes the process much simpler and less costly.

David H. Browne,[a] in an article entitled "Monel metal," gives the following data concerning this alloy:

Like steel, this alloy absorbs carbon, and, like steel, its physical properties are profoundly influenced, not only by the percentages of carbon, silicon, etc., but by the heat treatment it receives.

Standard analysis of monel metal.

	Per cent.
Nickel	68.00–72.00
Iron	.50– 1.5
Sulphur	.014
Carbon	.073– .15

Copper to balance.

This alloy is silver white and takes a brilliant finish, which it retains indefinitely.

In the rolled sheets the surface assumes on heating a coating of oxide, which has great resistance to acids. Samples of the rolled metal show no loss in fifty-six days' test in pumping 40° sulphuric acid.

Monel metal melts at 1,350° C. It can be rolled perfectly from 900° C. to 1,200° C., and its annealing temperature is above 875° C. It can be finished hard or soft, like sheet copper. Its specific gravity, as cast, is from 8.86 to 8.87, and when rolled from 8.94 to 8.95.

The cast monel metal is at present made in two grades, with the following qualities:

	Grade C.	Grade D.
Tensile strength	70,000	85,000
Elastic limit	27,000	40,000
Elongation in 2 inches, per cent	30	25
Reduction of area, do	35	25

These compare very favorably with the government specifications for carbon-steel castings.

In the rolled and annealed condition monel metal is stronger than nickel steel, as the following tests will show:

Average tests of monel metal 1-inch rods.

	As rolled.	Rolled, annealed, and cold drawn.
Tensile strength, pounds	100,000	110,000
Elastic limit, do	50,000	80,000
Elongation in 2 inches, per cent	30	25
Reduction of area, do	50	50

[a] Electrochem. and Metallurg. Industry, vol. 7, 1909, pp. 104-115.

* * * * * * *

We have here a metal possessing about 25 per cent greater tensile strength and 50 per cent greater elastic limit than the best rolled steel, with the additional quality of incorrodibility. The mechanical possibilities open to such an alloy are endless.

One of the most satisfactory uses of monel metal is in seamless tubes for condensers and boilers for automobiles and motor boats. The metal draws perfectly into a smooth tube, and its high elastic limit and tensile strength, combined with its incorrodibility, are of especial value in light machinery.

The largest casting so far made was a solid hub and propeller for the Southern Steamship Company's steamer *Creole*. This casting was 9 feet 6 inches in diameter and weighed 6,500 pounds. It has given perfect satisfaction.

In small cast propellers for hydroplanes or high-speed motor boats, the wheels are subjected to an enormous strain. The Hydroplane Company's engines turn from 1,500 to 2,000 revolutions per minute at 40 horsepower. With a blade 16 inches long, 40° pitch, and the edge of the blade thinned down to one-eighth of an inch, it required an extraordinary metal to withstand the strain.

Under these conditions standard manganese bronze bends at the blade tip and becomes useless. Monel metal has been given exhaustive tests in such service and proves absolutely rigid, and at the same time retains its original burnished surface.

The Missouri production of nickel was too small to be of importance in the American market during 1908. As usual, the United States drew its supply of nickel almost wholly from the Sudbury, Ontario, deposits controlled by the Orford Copper Company or its affiliated companies. Concerning conditions in the Ontario nickel mines, John McLeish writes as follows:[a]

With the exception of the nickel contained in the ores shipped from the Cobalt district, the production of nickel in Canada is derived entirely from the well-known nickel-copper deposits of the Sudbury district. Previous to 1906 the output had been increasing steadily for a number of years. During the past three years, however, the production has not varied very greatly. About 815 tons less matte was shipped in 1908 than in 1907. The nickel contents were also somewhat lower in 1908, averaging about 45.1 per cent, as compared with 48.1 per cent in 1907. On the other hand, the copper contents were higher in 1908.

Two companies are carrying on active operations—the Mond Nickel Company, at Victoria Mines, and the Canadian Copper Company, at Copper Cliff. The ore is first roasted and then smelted to a bessemer matte containing from 77 to 80 per cent of the combined metals, copper and nickel, which is shipped to the United States and Great Britain for refining. * * *

From the Cobalt district it is difficult to obtain satisfactory returns. The shippers of silver-cobalt ores receive little or no returns for the nickel contents, although this metal froms an important constituent of the ore.

Imports.—The imports for consumption of nickel into the United States since 1902, inclusive, as reported by the Bureau of Statistics, have been as follows:

Imports of nickel for consumption into the United States, 1902–1907.

	Nickel, nickel ore, and matte, nickel oxide, alloys of nickel with copper, etc.		Value of manufactured articles of nickel.	Total value.
	Pounds.	Value.		
1902	33,942,710	$1,407,521	$30,128	$1,437,649
1903	36,217,985	1,456,605	37,284	1,493,889
1904	19,739,315	1,118,541	2,950	1,121,491
1905	31,072,206	1,958,840	3,291	1,962,131
1906	34,082,042	1,867,568	8,963	1,876,531
1907	18,598,638	2,233,867	9,159	2,243,026
1908	16,825,291	2,487,605	9,980	2,497,585

[a] Eng. and Min. Jour., vol. 87, 1909, p. 564.

The imports for 1908 were divided as follows:

Nickel and nickel alloys	pounds..	227,584	$86,905
Ore and matte	do....	16,586,423	2,396,217
Nickel oxides	do....	11,284	4,483

Exports.—The United States refines much more nickel than it can use, so that although not a producer it is a large exporter. Exports since 1901 have been as follows:

Exports of nickel, nickel oxide, and matte from the United States, 1901-1908, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1901	5,869,655	$1,521,291	1905	9,550,918	$2,894,700
1902	3,228,607	924,579	1906	10,620,410	3,493,643
1903	2,414,499	703,550	1907	8,772,578	2,845,663
1904	7,519,206	2,130,933	1908	9,770,248	3,297,988

COBALT.

In the United States during 1908 cobalt was produced only by the North American Lead Company at Fredericktown, Mo., in connection with nickel and copper from concentrates obtained while mining for lead. The cobalt occurs in the mineral linnæite, a sulphide of cobalt, in which parts of the cobalt may be replaced by nickel, copper, and iron. Like nickel, it is found in company with sulphides of lead, copper, and iron in the form of gelena, chalcopyrite, and pyrite. The output, which can not be disclosed, was in the form of cobalt oxide. Cobalt sulphide occurs in the Standard Consolidated Mining Company's mine near Prairie City, Oreg., and a few tons have been mined from time to time, but none was produced in 1908. Cobalt is reported from a number of claims near Blackbird, Idaho, but the ores do not appear to be of high grade, and as they are over 100 miles from a railroad little can now be done with them.

Sporadic occurrences of cobalt are reported from many other places in the United States, a common mode of occurrence being in earthy manganese, called "asbolite," which carries some cobalt, but no deposits of such material are known that are of commercial value.

Because of its likeness to nickel, experiments have been made looking to the use of cobalt in steel, but so far with little success. Cobalt, nickel, and chromium are sometimes found together in iron ores, and Arthur W. Richards [a] states that from such ores excellent steel containing 1.41 per cent nickel, 0.25 per cent cobalt, and 0.32 per cent chromium was made. Although it is not clear that the cobalt was responsible for any of the good qualities of steel, it seems in the percentage given to have been in no way harmful at any rate.

The principal uses of cobalt at present are in making glass and pottery. A beautiful blue color is given to glass by the oxide of cobalt. Zaffer, a roasted cobalt ore, and cobalt oxide, arsenate, phosphate, and sulphate are used in coloring glass and in glazing and painting on porcelain and glass in blue colors. Cobaltous bromide, iodide, and chloride are used in hygrometers. Sympathetic inks are

[a] A method of producing high-class steel from pig iron containing chromium, nickel, and cobalt, Jour. Iron and Steel Inst., London, vol. 73, No. 1, 1907, pp. 114-125.

made from cobalt acetate, chloride, and nitrate that are colored when heated or colorless when cold. This is due to the change in color of the salts upon the absorption of water. When dry they are blue and easily seen on paper; when damp they are pink, and if dilute, colorless. A familiar hygrometer making use of this property is a doll the dress of which is blue in dry weather and pink in damp weather. Artificial flowers are made to show the same effect. Cobalt and potassium nitrate, cobalt yellow, is used as an oil and water-color pigment and for painting on glass and porcelain. Both this salt and cobalt nitrate are used in medicine. The latter is used in a 0.5 per cent solution, either internally or hypodermically, as an antidote for poisoning by hydrocyanic (Prussic) acid. It is also used in blowpipe analysis for the detection of aluminum, zinc, and magnesium. Sodium cobaltic nitrite is used in the detection of potassium, and luteo-cobaltic chloride is used as a reagent for pyrophosphoric acid. The sulphate, chloride, and metal have been used in electroplating steel, iron, copper, brass, and zinc. Cobalt paper, made by charging white paper with cobaltous chloride solution, colored blue with methylene blue and dried, is used as an indicator in the volumetric estimation of zinc, copper, and nickel, using sodium sulphide. An excess of the sulphide develops a black spot on the paper.[a] Cobalt has been used in storage batteries, but is said to be too expensive for the purpose.

Cobalt gives a beautiful and characteristic blue color in a bead of borax glass or salt of phosphorus. This test is not always applicable, however, since iron, copper, and nickel interfere and disguise the color given by the cobalt.

Ontario, Canada, and New Caledonia are the great producers of cobalt, and owing to the working of the silver mines at the town of Cobalt, Ontario, where large quantities of cobalt minerals are contained in the ore, the world's supply of cobalt has been largely increased, so that the price dropped considerably during 1908. Concerning this supply, Thomas W. Gibson, deputy minister of mines, Toronto,[b] says:

> The cobalt-oxide industry suffered from the excessive supply of cobalt ore thrown on the market as a by-product from silver smelting. The world's consumption of oxide annually falls far short of the production from the mines of Cobalt, and consequently the price of oxide fell from $2.50 to $1.40 per pound. The only relief is in a widely extended use for cobalt, which is at present chiefly employed in making the color known as "cobalt blue."

The imports for consumption of cobalt into the United States since 1901 have been as follows:

Cobalt oxide, ore, and zaffer imported into the United States for consumption, 1901–1908, in pounds.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1901	71,969	$134,208	1905	70,048	$139,377
1902	79,984	151,115	1906	41,084	83,167
1903	73,350	145,264	1907	48,013	74,849
1904	42,354	86,925	1908	219,098	17,077

[a] A number of the uses for cobalt are taken from Merck's (1907) Index, 3d ed., pp. 144–145.
[b] Ontario: Eng. and Min. Jour., vol. 87, 1909, p. 134.

The imports for 1906 included 12,850 pounds of ore and zaffer; those for 1907, 5,219 pounds, valued at $1,821; those for 1908, cobalt, cobalt ore, and zaffer, 217,548 pounds, valued at $13,982, and cobalt oxide, 1,550 pounds, valued at $3,095. The great increase in the quantity of ore imported is probably due to importations of silver ore from Cobalt, Ontario, from which cobalt is produced as a by-product.

During the first part of 1908 cobalt oxide was quoted at $2 per pound in the technical magazines, and it would possibly have staid near this figure during the whole of the year in spite of the great output from the Ontario silver ores, for the product was in strong hands; but, after the North American Lead Company, of Fredericktown, Mo., entered the market the price fell and was soon down to $1.40. Whether the two events depended upon each other can not be positively stated, but they were closely connected as to time. The price remained at about $1.40 per pound during the latter part of 1908.

VANADIUM.

So far as reported to the United States Geological Survey, no vanadium ores were sold in the United States during 1908.

The principal known vanadium deposits of this country are at Newmire, near Placerville, Colo., where the mineral occurs as roscoelite, a green vanadium mica in the soft La Plata (Jurassic) sandstone.

The content of the ore in vanadium probably does not exceed 2 per cent.

Picked specimens collected by F. L. Ransome of this Survey and analyzed by W. F. Hillebrand [a] gave an average of 3.50 per cent V_2O_3, or only about 2.4 per cent metallic vanadium.

Vanadium occurs in carnotite in sandstones farther west and north along the Utah–Colorado line, on La Sal and Roc creeks and in Sinbad Valley; still farther west at several points on the east slope of the La Sal Mountains in Utah; in the northern part of Colorado on Coal Creek, near Meeker in Rio Blanco County, where it occurs in the Dakota (Cretaceous) sandstone; and 2 miles west of Skull Creek in Routt County, in Jurassic sandstone. A small production of vanadium salts as a by-product in treating carnotite for uranium, has been made at a plant operated by Alfred H. Hale, near Cedar, San Miguel County, Colo. The rock is reported to carry from 1 to 10 per cent of vanadium. Nothing was done during 1908 at this plant.

Roscoelite is found sparingly in the gold veins of Boulder County, but in too small quantity to be of commercial value. Small quantities are also found in connection with gold deposits near Placerville, Cal.

As vanadinite, a lead-chlorine vanadate, and related minerals, endlichte, descloizite, etc., vanadium occurs in the oxidized zone of lead-bearing veins in Montana, Colorado, New Mexico, Arizona, California, and other States. Some of these ores have been produced commercially in New Mexico and Arizona; but most of the minerals mined have been sold to smelters for their lead content.

Vanadium finds by far its most important use in steel. Remarkable claims are made for the toughness added to steel through the use of small quantities of vanadium. Its effect in steel is said to be owing

[a] Bull. U. S. Geol. Survey No. 262, 1905, p. 21.

to its removing oxygen and nitrogen, to its forming a solid solution with the iron, and to its forming carbides which have a beneficial effect upon the steel. It is claimed that after treatment with vanadium steel has great resistance to shock and to fatigue caused through constant bending; that it makes much better saws and springs; and that high carbon vanadium steels also make much better tools, such as cutters and riveting dies. About 0.1 per cent of vanadium is used for deoxidizing and denitrogenizing the steel, and about 0.25 per cent of vanadium is left in the steel itself. It is ordinarily used with chromium or manganese, or both, to which nickel may also be added.

The use of vanadium in cast iron also is said to be beneficial, and encouraging experiments are reported to have been made with its introduction into brass and bronze.

Attempts to use vanadium as a filament for incandescent electric lamps were unsuccessful, owing to the low melting point of the metal.

Dr. Fritz Ephraim quotes the following uses:[a]

With aniline as a black dye; as V_2O_5, it has been used in place of platinum in the contact process for the manufacture of sulphuric acid (though it is said to be less effective than platinum); as a photographic developer. In medicine salts with potassium chlorate have been used under the name of "vanadin." Vanadium salts are said to be favorable to the growth of plants; vanadyl phosphate acts physiologically like potassium permanganate; from vanadates and tannic acid a waterproof black ink is made; vanadium salts are used in coloring glass; vanadic acid is used to determine hydroxylamin and hydrazin in the presence of ammonia.

Metavanadic acid has been used to some extent as a substitute for gold bronze in paint. Vanadium chloride is used as a mordant in printing fabrics, and the trioxide as a mordant in dyeing.[b] Vanadic anhydride (V_2O_5) has been used in the "reduction of various organic compounds in an acid bath, e. g., the manufacture of quinone from aniline, etc. It also greatly accelerates certain oxidation processes, such as the action of nitric acid on sugar, the oxidation of alcohol by atmospheric oxygen."[c]

During 1908 the United States drew its supply of ore mostly, if not wholly, from Cerro de Pasco, Peru, where there are large deposits of a peculiar carbonaceous sulphide of vanadium known as patronite. These deposits are reported to be largely controlled by the American Vanadium Company of Pittsburg, Pa. As reported by S. Jochamowitz in the Engineering and Mining Journal, May 15, 1909, over 300 tons of ore were imported from these deposits during 1908. No separate record of imports of vanadium ore is kept by the Bureau of Statistics.

TITANIUM.

No titanium ores are known to have been mined and marketed as such in the United States during 1908, though some ore was sold that had been mined in previous years. The titaniferous iron ores of Wyoming, Minnesota, and New York are mined in greater or less quantities, but so far as known they are used for iron alone, though it is possible that some of the Adirondack ores have been used in making ferrotitanium.

In the rutile-bearing district of Nelson County, Va., the General Electric Company continued prospecting operations on their prop-

[a] Ephraim, Fritz, Das Vanadin und seine Verbindungen: Sammlung chemischer und chemisch-technischer Vorträge, vol. 9, pts. 3-5, Stuttgart, 1904, pp. 83-84.
[b] Merck's (1907) Index.
[c] Roscoe and Schorlemmer, Treatise on chemistry, 1907, vol. 2, The Metals, p. 898.

erty, 7 miles northwest of Tye River post-office, and 3½ miles south of Roseland. Several hundred feet of tunneling, including an adit and drifts has been done, and a shaft 100 feet deep has been sunk.

The geology of the deposit is almost, if not quite, unique. A biotite gneiss is cut by huge pegmatite dikes, whose widths are unknown owing to the soil covering, but they are to be measured in hundreds of feet. The dikes are composed of albite and orthoclase feldspars, blue quartz, white apatite, and hornblende, which is generally much altered. There is no muscovite mica and only a little biotite, and the latter may have been derived from the decomposition of hornblende. Rutile occurs as an original mineral, in places very pure and in other places showing constituent quantities of iron. There seem to be a series of minerals containing mixtures of titanium and iron oxides, which range from rutile to ilmenite. The percentages of the rock-forming minerals vary considerably from point to point. Much crushing has taken place since the intrusion of the dikes. Where hornblende formed a considerable proportion of the mass, the rock has been crushed to a gneiss; where hornblende is in smaller proportion, the rock is massive and without regular structure.

Rutile does not occur in the pegmatite on the General Electric Company's property in a percentage large enough to allow economical working; but the pegmatite is cut by two smaller dikes composed of rutile, ilmenorutile, and apatite, upon which their prospecting work has been done. These dikes are between 100 and 150 feet apart. The larger one can be followed by its outcrop for half a mile and possibly more. Where developed it varies from a few inches to 5 feet in thickness. Shoots show good, comparatively clean rutile; but away from the workings the titanium mineral carries too much iron to be called rutile, and it has a purplish tint entirely different from ilmenite. Although no analyses are at hand, it may fairly be surmised that it is a mineral having a composition between the two.

The other dike is smaller, but in the workings has shown a thickness of 3 feet of excellent ore. There is a small quantity of pyrite in the dikes, which follows joints, and is clearly of later deposition than the dikes. At the surface the rutile is much lighter-colored than at depth, and has possibly had part of its iron leached out.

An appearance of imperfect crustification may be seen in places which suggests that the rutile, ilmenorutile, apatite deposits should rather be called veins than dikes; but it seems more probable they are only a later phase of the pegmatite which they cut.

At Roseland the American Rutile Company quarries the pegmatite for rutile. The rutile here forms about 4 per cent of the rock. The company has a 10-stamp mill with engines, pumps, concentrating tables, and other necessary machinery. The residual soil covering the deposits contains considerable rutile and is also run through the mill. To make a very clean concentrate the product of the tables is treated by a Wetherill magnetic separator, and the resulting rutile contains over 98.42 per cent TiO_2; selected ore has given a product of 99.22 per cent TiO_2. The company's property lies on both sides of Tye River, and contains great quantities of ore. The rutile originally formed aggregates which in places had a bulk of several cubic inches, but they have been so mashed by dynamic metamorphism as to take the form of wavy lines of small fragments. Apatite is in places closely associated with the larger aggregates of rutile.

A mile north of the mill on the company's property is a dike of rutile-apatite rock from 3 to 5 feet wide and exposed for a length of between 100 and 200 feet.

No production was made by the company during 1908, but their stock of rutile was largely sold and it is expected that there will be a production in 1909.

Besides the three rutile-apatite bearing dikes described, no others are known, but there are a considerable number of ilmenorutile[a] and ilmenite-apatite dikes in Nelson County. One of the latter upon the American Rutile Company's property is 30 feet thick and is said to be half a mile long. This rock has been called Nelsonite by Dr. Thomas L. Watson,[b] who is now conducting a detailed geological survey of the rutile-bearing area. The same rock also occurs in Roanoke County in similar dikes.[c]

For uses of titanium compounds where the presence of some phosphorus will not be especially injurious, these dikes may become of value as a source of titanium, as the percentage of titanium contained in concentrates would probably be higher than in the ordinary titaniferous iron deposits and much more constant.

In spite of considerable searching no other deposits of rutile in commercial quantity have been found in this country. Other deposits are known in southern Norway, South Australia, and Queensland, but rutile is shipped to Europe by the American Rutile Company in competition with that from the Norwegian and other deposits. A few pounds of very pure rutile is from time to time picked up in the fields of Chester County, Pa. This rutile is well crystallized, and is sold for collections and to the dental trade for coloring artificial teeth. The price was formerly about $1 per pound, but rutile, which is probably as pure, can now be purchased at a few cents per pound. Some Queensland (Australia) rutile has been imported which shows only a trace of iron.

The price of rutile varies from $40 to $150 per short ton, depending on purity and quantity.

The use for titanium which seems to give promise of greatest expansion is in steel and cast iron. In steel it is ordinarily added in the form of ferrotitanium, containing preferably from 10 per cent to 20 per cent titanium. This is added in quantity sufficient to be about 0.1 per cent of the steel. The office of the titanium is to combine with any oxygen or nitrogen contained in the steel. Rails treated with titanium and laid in places upon railroads where the wear was especially hard are said to have shown much less loss by wear than untreated rails. Gray cast iron also is said to show beneficial effects from such treatment.

Ferrotitanium is manufactured both by the thermit and the electric furnace processes. Titanium-thermit, a combination of thermit and a titanium compound, is now on the market as a means of introducing titanium into steel ladles. Cuprotitanium is also being manufactured for use in bronze and other castings containing copper. The titanium is said to act as a deoxidizer, much like phosphor-tin, and to make very tough castings.

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[a] By ilmenorutile is meant in this article a mineral containing too much iron to be classed as rutile and too much titanium to be classed as ilmenite.

[b] Mineral Resources of Virginia, Lynchburg, 1907, p. 300.

[c] Idem., p. 301.

Another use of titanium which promises to assume considerable proportions is the manufacture of electrodes for arc lights. These are of two types, in one of which ground titanium carbide is used in an iron tube (to supply conductivity); in the other titanium-bearing magnetite is used. Such electrodes are used for only one pole, with a carbon block for the other one. The General Electric Company now has lamps burning both kinds of electrodes in use, and several other companies are experimenting along the same line.

The use of titanium as a filament for incandescent lamps has not yet reached the commercial stage, but experiments are still in progress. Titanous chloride ($TiCl_3$) has been used to some extent in dyeing, as a mordant, but is said to have little, if any, advantage over stannous chloride for the purpose. Titanous sulphate ($Ti_2(SO_4)_3$) is used as a stripper and mordant, and titanous potassium oxalate as a yellow dye and a mordant in the dyeing of leather. Other compounds are also used in dyeing. In chemical work a solution of titanium sulphate ($Ti(SO_4)_2$) is oxidized by hydrogen peroxide, and the degree of decolorization of the resulting straw-colored liquid by fluorine is used to determine the quantity of fluorine present. Very small quantities of fluorine can be determined in this way.

In porcelain tile, rutile is used to give a soft, beautiful yellow color. It is also used to color artificial teeth. For this last use, however, only the purer grades of rutile can be employed. Baskerville[a] mentions the use of titanium in pyrotechnics, though he does not mention what salts are used, and he notes also that "titanium ferrocyanide is used as a substitute for the poisonous Schweinfurth green and other arsenical pigments."

In the blast furnace and electric furnace, owing to the affinity of titanium for nitrogen, titanium nitride is sometimes formed during the smelting of titaniferous iron ores. It has been proposed to make use of this property by smelting titaniferous ores in such a way as to form titanium nitride from all the titanium present and use it as a fertilizer.

The ordinary titanium minerals, rutile and the varying forms of TiO_2, are insoluble in acids, and most other titanium compounds are nearly or quite so. To test them, fuse with sodium or potassium bisulphate, dissolve in water, acidify slightly with sulphuric acid, and add hydrogen dioxide. If titanium is present an orange color will result. Columbium gives nearly the same color. If a verification of the test is desired, to a cold hydrochloric acid solution add metallic zinc and a delicate lilac color will be obtained.

No separate records of the imports or exports of titanium minerals or artificial compounds are available.

MOLYBDENUM.

No sales of molybdenum ore produced in the United States during 1908 have been reported to this office, and there has been little development of molybdenum properties, though some such work was done in Arizona, California, Colorado, and Washington.

Like tungsten, molybdenum is used as a steel alloy, but the demand for molybdenum is, at best, small in this country, as few firms use it in

[a] Baskerville, Charles, The rare metals, VI, Titanium: Eng. and Min. Jour., vol. 87, p. 10.

making steel, so that, as with tungsten, the demand was probably less during 1908 than in 1907.

Only two minerals are known to be used commercially as a source of the metal, molybdenite, the sulphide, and wulfenite, lead molybate. Molybdenite is found sparingly in many parts of the United States in which granitic rocks abound, though the number of places at which it is found in commercial quantities is not great. The ease or difficulty of concentration has much to do with the feasibility of mining molybdenite deposits. Unless the mineral occurs in large lumps, so that it may be hand picked, it seems to be difficult to find a satisfactory method of separating molybdenite from its gangue, although exponents of both oil and static electric methods claim that these methods are successful. Wulfenite occurs in the oxidized zone of lead ores at a number of places in Utah, Nevada, Arizona, and New Mexico, and sparingly in California and other States. To be useful as a source of molybdenum, wulfenite must not carry as impurities large quantities of copper, arsenic, vanadium, or iron.

To test molybdenum minerals, moisten the pulverized mineral with concentrated sulphuric acid in a porcelain crucible and evaporate almost to dryness. Upon cooling, if molybdenum is present, the crucible will have a beautiful dark blue coating, which is thought to be a mixture of oxides.

This test is readily and easily performed, is characteristic, and no element or mineral accompanying molybdenum compounds is known to interfere with the test.

The mineral with which molybdenite is likely to be confused is graphite. Graphite in places occurs in flakes which are almost, if not quite as flexible as those of molybdenite, and on the other hand, molybdenite occurs at certain places in a form which gives no suggestion to the eye of a flaky structure. There is generally a noticeable difference in color, the graphite being black and molybdenite having a grayish metallic appearance, but even these characteristics are not sure. An impure molybdenite from near Davenport, Wash., is glossy black with no suggestion of flakiness and gives a black streak, though the streak of molybdenite on white paper is usually olive tinted. Besides the test given molybdenite may be differentiated from graphite by treatment with nitric acid. Molybdenite is attacked by the acid, with a resulting white or gray powder (molybdic oxide), while graphite is unaltered.

Uses.—Molybdenum has been used in making tool steel, and several steel works in the United States are said to produce it, but it is often stated that, although molybdenum gives properties to steel similar to those given by tungsten, the steel is apt to crack in forging.

Molybdenum in the form of ammonium molybdate is used to determine phosphorus in iron. In the United States alone its use for this purpose amounts to several tons per year. In Europe ammonium molybdate is used as a fireproofing material, as a disinfectant for cloth used in railway passenger coaches, and for similar uses. It is said to be a strong germicide. Sodium molybdate is used to give a blue color in making pottery and in dyeing silks and woolens.

Molybdenum produces fast shades on leather just as titanium does, and a large variety of shades may be produced by using molybdenum tannate with logwood extracts. "Molybdenum indigo" (Mo_5O_7) is

a useful but expensive pigment for india rubber. It is said that it is not injurious to the material.[a]

Efforts have been made to use metallic molybdenum as a filament for incandescent electric lights, but they have not been successful owing to its comparatively low melting point. As ordinarily reduced, molybdenum is a bluish powder, but it may be smelted, either by the use of thermit or in the electric furnace, into a bright metal much resembling aluminum in color. When pure the metal is malleable, and may be filed and drawn into wire; in the form of wire it is used as a support for tungsten filaments in incandescent lamps.

No separate record is kept of the imports or exports of molybdenum minerals or salts, or of ferromolybdenum.

Both molybdenite and wulfenite are used as ores. The price of molybdenite ordinarily ranges between 20 cents and 30 cents per pound for material carrying 92 per cent of molybdenum sulphide. The price of wulfenite is a matter of contract, depending largely upon the purity of the material, and no quotations can be given. The price of the metal, as quoted in the Mining World during 1908, was $1.45 to $1.50 per pound.

URANIUM.

Uranium is found commercially in only two minerals in the United States, viz, as pitchblende and as carnotite, although it is found sparingly in others.

Pitchblende, which is the uranium mineral most widely known because of its use as an ore of radium, the spectacular properties of which have attracted almost universal attention, is found in quantity in the United States only in Gilpin County, Colo., where it occurs in the Kirk, Wood, German, and Belcher mines.

The Belcher mine, 1 mile southwest of Central City and about 2 miles from Black Hawk, was operated during 1908 by W. H. Malet and associates. The vein, which was struck at a depth of 120 feet, is reported to be in schistose granite, which in places gives way to porphyry. The shaft has been sunk to a depth of 135 feet, and drifts have been run in both directions upon the vein. The pitchblende is from one-half inch to 8 inches thick, generally on the foot wall. A specimen from the mine shows a vein about three-fourths of an inch thick, which is made up of a double layer of radial mammillary concretions an eighth of an inch across, between which is pitchblende, showing no definite structure, and some pyrite. Quartz, galena, tetrahedrite, and chalcopyrite are reported to be associated with the pitchblende.

The German mine is just west of the Belcher on what is thought to be the same vein, while the Wood and the Kirk mines are south on parallel veins. Pitchblende has been known in the Wood mine since 1871.[b] At that time the mine was worked for gold. Gold and silver are reported from at least two of the veins. Some pitchblende, which had been produced at a former period, was sold from one of the mines early in 1908, and another mine produced ore which was not sold during the year. From one of the mines an unreported quantity

[a] Baskerville, Charles, The rare metals, III, Molybdenum: Eng. and Min. Jour., vol. 86, 1908, p. 1055.
[b] Pearce, Richard, Some notes on the occurrence of uraninite in Colorado: Proc. Colo. Sci. Soc., vol. 5, 1895, p. 156.

of ore was shipped to Chicago to an analytical firm, who undertook concentration and other tests upon it.

Carnotite is not properly referred to as a mineral, as it is a mixture of uranium and vanadium salts. It occurs as a bright characteristically yellow powder in sandstones in the vicinity of La Sal and Roc creeks and Paradox Valley, in Montrose County; at various points in San Miguel and Dolores counties; in adjoining districts in Utah; and in northwestern Colorado on Coal Creek near Meeker, in Rio Blanco County, and 2 miles west of Skull Creek, in Routt County. In the southwestern part of Colorado and in southeastern Utah the deposits are in Jurassic (La Plata) sandstone, in which the Skull Creek deposits also occur. The Coal Creek occurrence is in Cretaceous (Dakota) sandstone.

At most places the carnotite occurs in the interstices between the grains of the sandstone and in thin coatings of cracks and crevices in the sandstone; but in some places considerable lumps, up to several inches in thickness, of nearly pure material are found.

As noted in former reports, some uranium and vanadium salts have been extracted at the Haynes plant, near Cedar, Colo. The haul for supplies and material is long and expensive, and the ore is lean, so that the problem of economical extraction is difficult. The plant was not operated during 1908.

Uranium minerals are radioactive, and this property may easily be tested by placing the suspected mineral upon a photographic plate, which may be wrapped in black paper and left in a dark place for from twenty-four hours to three or four days. Keys, coins, or similar objects may be placed between the specimen and the plate, and if radioactivity is present, upon development the plate will show shadows of the objects. This effect is always given by uranium minerals, but it is also given by most thorium minerals. No easy chemical test can be given, but if the mineral is radioactive it can then be submitted to analysis.

Uranium has not yet been put to many practical uses. It has been experimented with as a steel alloy, and one dealer assured the writer that he knew it to be used in one large German gun works in the manufacture of steel. Merck's (1907) Index also states that uranium is used in the manufacture of gun barrels. Various uranium salts are used in iridescent glass and pottery glazes. Uranium and sodium acetate is used in chemistry in the determination of phosphates; uranyl acetate is used in medicine as a precipitant for proteids; and also in the volumetric determination of zinc; for the latter purpose uranium nitrate is also used. The nitrate is used in photography in glazes, in the detection of morphine, and in the determination of arsenic and of phosphoric acid. The trioxide, or red oxide, is used to paint on porcelain and in calico printing. A number of the uranium salts are violent poisons.

Uranium oxide and uranium salts were imported into the United States during 1908 to the value of $7,145.

TANTALUM.

No production of tantalum minerals is known to have been made in the United States during 1908.

The only minerals found in this country from which tantalum can be commercially produced are tantalite and columbite, minerals

which grade into each other. Tantalite is an iron tantalate ordinarily carrying manganese and columbium. The ratio of tantalum and columbium may be greatly different in specimens from the same locality. When the columbium is in excess, the mineral is known as columbite. There is a fairly good correspondence between the quantity of tantalum present and the specific gravity of the mineral, the latter rising with the increase of tantalum contained. A columbite from Greenland, the analysis of which is quoted by J. D. Dana,[a] had a specific gravity of 5.395; another from Mineral Hill, Pa., in which the iron was largely replaced by manganese, had a specific gravity of only 5.26; and a nearly pure tantalite from Grizzly Bear Gulch, S. Dak., had a specific gravity of 8.200.

Tantalite and columbite are found at least sparingly in most places where pegmatites are common. In the United States they occur in considerable quantity in the Black Hills of South Dakota;[b] in less quantity near Canon City, Colo.; and as occasional pieces near Spruce Pine and other points in North Carolina; near Amelia, Va., and in many other places.

The only practical use to which tantalum is now known to be put is in making filaments for incandescent electric lamps, though, owing to its ductility, hardness, toughness, and resistance to corrosion, many other uses have been proposed. More than twenty thousand 20-candlepower incandescent electric lamp filaments can be made from a pound of tantalum, so that the market is at present not large, and is probably supplied by rich mangano-tantalates from Western Australia, though the quantity sold during 1908 was valued at only $1,946.60.[c]

Tantalum lamps are manufactured in this country from tantalum made by Siemens-Halske A.-G., in Germany, and imported at a cost of $300 or over per pound. The imports are unknown.

There are no known field tests for tantalum and columbium upon the results of which any reliance can be placed. The mineral with which tantalite or columbite is most likely to be confused is ilmenite, which may be differentiated by the test for titanium. Magnetite, which may occur in the same association, can often be told by its octahedral cleavage, and almost invariably by its magnetic quality. Cassiterite is translucent in thin splinters, and may be reduced to metal by being placed in hydrochloric acid with zinc.

The differentiation of tantalum from some of the other rarer minerals is not so easy.

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[a] System of Mineralogy, 1892, p. 733.

[b] The South Dakota columbite deposits are briefly treated by the author of this article in Bull. U. S. Geol. Survey No. 380, 1909.

[c] Letter from A. Gibb Maitland, government geologist, dated April 19, 1909.

CHROMIC IRON ORE.

By E. C. Harder.

INTRODUCTION.

The mining of chromite or chromic iron ore in the United States is an industry of small importance, due to the limited extent of the deposits. The association of chromite with basic igneous rocks is widespread, but deposits of workable size are rare. Commercially important deposits have been found only in Pennsylvania, Maryland, North Carolina, Wyoming, and California, and the last-named State is the only one which has for many years been a commercial producer. The total production of chromic iron ore in the United States in 1908 was 359 long tons. All the ore was used for furnace linings. When compared with the imports, the domestic production of chrome ore becomes insignificant. In 1908 there were 27,876 long tons of chrome ore imported into the United States, the greater portion of which came from New Caledonia, Greece, and Canada.

SOURCES OF CHROMIUM.

Chromium is found as an accessory constituent in a variety of minerals, but chromite or chromic iron ore is the only one of commercial importance. Small quantities of chromium have been obtained from crocoite.

The following is a list of minerals containing chromium:

List of chromium minerals.

Chromite	$(FeMg)O\ (CrAlFe)_2O_3$
Picotite (chrome spinel)	$(MgFe)O\ (AlCr)_2O_3$
Crocoite	$PbO\ CrO_3$
Phoenicochroite	$3PbO\ 2CrO_3$
Vauquelinite	$2(PbCu)O\ CrO_3\ 3(PbCu)O\ P_2O_5$
Uvarovite (chrome garnet)	$3\ CaO\ (AlCr)_2O_3\ 3SiO_2$
Chrome diopside	$CaMg(SiO_3)_2\ nCr_2O_3$
Emerald (chrome beryl)	$3BeO\ Al_2O_3\ 6SiO_2\ nCr_2O_3$
Redingtonite	Hydrous chromium sulphate
Daubreelite	$FeS\ Cr_2S_3$

Theoretically the composition of chromite is $FeO\ Cr_2O_3$, with 32 per cent ferrous oxide (FeO) and 68 per cent chromic oxide (Cr_2O_3). Practically, however, the percentage of chromic oxide varies down to 10 in the ores, though generally ranging between 40 and 60, while the ferrous oxide content varies from 10 per cent to 50 per cent. Alumina and magnesia are almost invariably present and sometimes form a considerable percentage of the ore, alumina being present in quantities varying up to 30 per cent and magnesia in quantities varying up to 20 per cent. Alumina replaces chromium and magnesia replaces ferrous iron.

USES OF CHROMIUM.

The uses of chromium may be classified as follows: (1) Metallurgical, in the manufacture of alloys and of furnace linings; (2) chemical,[a] as a constituent in coloring materials, mordants, oxidizing agents, and tannages.

METALLURGICAL USES.

Chromium alloys.—The chief alloys in which chromium is a constituent are (A) ferrochromium, (B) ternary chromium steel, (C) quaternary chromium steels, such as chromium-nickel steel, chromium-tungsten steel, chromium-manganese steel, and chromium-molybdenum steel. Chromium has been alloyed with other metals in cases where great hardness is required.

A. Ferrochromium[b] is a tin-white, hard, brittle alloy, with crystalline structure, varying from fine crystalline aggregates to coarse crystals. It is used in the manufacture of chromium steels. The commercial product carries from 50 to 70 per cent chromium and from 0.5 to 10 per cent carbon. High-grade low-carbon ferrochromium contains from 0.5 to 1 per cent carbon, while high-carbon ferrochromium may contain as high as 10 per cent carbon. The carbon is present in the form of carbide. The high-carbon product is not reliable in steel manufacture,[c] as flaws in chromium steel have been traced to the presence of crystals of carbide of chromium due to the use of an alloy too high in carbon.

Ferrochromium has been produced in several ways.[d] One of the first methods of manufacture was by mixing bichromate of potassium with powdered wood charcoal, steel turnings, and broken glass, and reducing the mixture in pot crucibles. A ferrochromium containing 55 per cent chromium was obtained, which, however, contained a large percentage of carbon. Another method of preparation was by mixing pulverized chromic iron ore with powdered charcoal and tar, and heating the mixture in iron vessels to a point just short of ignition. This material was then thoroughly mixed with broken glass and lime, and heated in old steel crucibles to such an extent as to fuse the entire mass. The button of ferrochromium was then removed from the bottom of the ruined crucible. Later ferrochromium was produced in cupola furnaces, and still later in electric furnaces, the latter being now the prevailing method. Even recently, however, ferrochromium was produced in the Urals in eastern Russia in a charcoal blast furnace.[e] The blast was heated to 400° C. and ore of the following composition was used:

FeO	17.55
Cr_2O_3	44.23
SiO_2	5.70
Al_2O_3	14.14
MgO	16.09
MnO	0.74
CaO	1.29

[a] Thorp, F. H., Outlines of Industrial Chemistry, 1901, pp. 137, 203–209, 458, 493.
[b] Brannt, W. T., Metallic Alloys, 1896, p. 43.
[c] Chromium steel: Jour. Iron and Steel Inst., No. 4, 1906, p. 926. (Review.)
[d] Brustlein, A., Chromium steel: Jour. Iron and Steel Inst., No. 2, 1905, p. 782. (Review).
[e] Lipin, W. N., Stahl und Eisen, vol. 25, pp. 617–618.

This was mixed with slagging materials in the following proportions:

Ore	42.9	47.1
Limestone	14.2	12.4
Sand	20.3	21.2
Mill cinder	23.6	19.3

The mixture was then fed to the furnace with charcoal in the proportion of 0.102 ton to 0.218 ton birch charcoal. The resulting alloys averaged about 30 per cent chromium, though occasionally a 50 per cent ferrochromium was produced.

Several double carbides [a] have been isolated from ferrochromium and chromium steel, such as $Fe_3C\ 3Cr_3C_2$ in ferrochromium with 57 to 59 per cent chromium, and $2Fe_3C\ Cr_5C_2$ in low-grade chrome steel. The carbides $3Fe_3C\ 2Cr_3C_2$ and $2Fe_3C\ 3Cr_3C_2$ have been obtained in the electric furnace.

Iron is saturated with carbon when it contains about 4.2 per cent.[b] The presence of chromium makes little difference up to about 10.4 per cent. When increased above this, however, the saturation point of iron for carbon increases, reaching about 9.2 per cent for 62 per cent chromium.

B. Chromium steel alone or alloyed with tungsten or molybdenum is used in the manufacture of high-speed tools. It is also used in the manufacture of files, ball bearings, armor plates, and armor-piercing projectiles, for which uses it is generally alloyed with nickel or manganese.

Chromium gives to steel a marked degree of hardness and, if added in the proper proportion, does not produce brittleness. The properties of chromium steel vary with the quantity of chromium and carbon present.[c] The presence of excessive carbon tends toward brittleness on account of the development of double carbides of chromium and iron.

Ternary chromium steel (steel containing only chromium, iron, and carbon), with a percentage of chromium under 7, has the microstructure of ordinary carbon steel, consisting of perlite with ferrite or cementite, and is very hard and strongly resists impact. Steel with a percentage of chromium between 7 and 20 has a fibrous structure known as martensite. As the chromium increases above 15 per cent, small quantities of carbide grains begin to appear. When carbon is present up to several per cent, reniform granules of troostite become mixed with the martensite. The steels thus formed are more brittle than the martensitic steels, and this brittleness is increased by the addition of carbon. On increasing the percentage of chromium above 20, there is a marked development of minute white grains consisting of a double carbide of iron and chromium. With an increase of this constituent, the steel becomes very brittle. A change in the carbon percentage changes somewhat the limits between which these various microstructures and the consequent physical properties prevail.

Quenching acts upon low chromium steels in the same manner as upon carbon steel, but with far greater intensity. Martensitic chro-

[a] Guillet, L., Chrome steel: Jour. Iron and Steel Inst., No. 2, 1904, p. 613.

[b] Goerens, P., and Stadeler, A., Influence of chromium on the solubility of carbon in iron (Review): Jour. Iron and Steel Inst., No. 3, 1907, p. 518.

[c] Guillet, L., Chrome steel (Review): Jour. Iron and Steel Inst., No. 2, 1904, p. 611; also Quaternary steels: Jour. Iron and Steel Inst, No. 2, 1906, p. 7.

mium steel is little altered by quenching, while troostitic steel is hardened. Steels containing over 20 per cent chromium are slightly softened by quenching. Annealing softens all chromium steels.

C. Quaternary chromium steels[a] are chromium steels which contain, in addition to iron, carbon, and chromium, one other element, generally nickel, manganese, or tungsten. In a general way, the microstructure of quaternary steels is a superposition upon each other of the microstructures of the two ternary steels composing them. However, as the sum of the elements—carbon, chromium, and either nickel, manganese, or tungsten—increases, a mixture of the next higher microstructure of the constituent ternary steels begins to develop, this development being in advance of the development of these structures in either ternary steel alone. For example, if martensitic nickel steel be added to martensitic chromium steel, there will be little or no change of structure until considerable material has been added. At length, however, the characteristic polygonal structure of γ iron mixed with grains of carbide will develop in the martensite, the γ iron structure being characteristic of the next higher nickel steel and the carbide grains of the next higher chromium steel. This mixed texture will develop before either would develop in the ternary steel of which it is characteristic.

As the physical properties of ternary and quaternary steels are dependent upon the microstructure, a consideration of the latter is important.

The following structures are found in nickel chromium steels: Perlite, martensite, martensite mixed with carbide, γ iron, γ iron and carbide.

In these steels the nickel varies from 1 to 30 per cent, the chromium from 1 to 20 per cent, and the carbon from 0.1 to 1 per cent. The equivalents of these elements are: Nickel, 29, chromium, 18, and carbon, 1.65. If chromium be added to perlitic nickel steel (low in nickel), the latter may, if the addition is sufficiently small, retain its structure, provided the sum of the elements—C and Ni and Cr—be fairly low. As the sum of the elements increases, martensite is formed.

If chromium be added to martensitic nickel steel (medium low in nickel), the latter may retain this structure if the quantity added is small. As more is added, carbide will develop through the martensite, the amount depending upon the percentage of carbon present. At length, a small quantity of γ iron also develops, and if the addition of chromium is sufficient the martensite may disappear altogether.

When chromium is added to nickel steel containing γ iron (high in nickel), it has no effect on the structure until a considerable percentage is present, when carbide is formed. The percentage of chromium necessary is lower in proportion as the carbon present is high.

Only the perlitic steels and those containing γ iron are of value commercially. In these the chromium increases the hardness without diminishing the resistance to shock so characteristic of nickel steels. They are therefore very desirable for armor plates and armor-piercing projectiles. It has been suggested that they may also be used for high-speed tools and for ball bearings. The steels containing martensite and carbide are very hard and brittle.

[a] Guillet, L., Quaternary steels: Jour. Iron and Steel Inst., No. 2, 1906, pp. 111–140.

The following structures are found in manganese chromium steels: Perlite, martensite with or without carbide, γ iron with or without carbide.

In these steels the manganese varies from 1 to 15 per cent, the chromium from 1 to 6 per cent, and the carbon from 0.1 to 1 per cent.

Apparently the addition of chromium to manganese steel has no other effect on the microstructure than the addition of more manganese would have, with the exception that if the percentage is sufficiently high some carbide is formed, especially if the carbon also is increased. The physical properties of manganese-chromium steels are similar to those of nickel-chromium steels, and in many cases it might be possible to substitute manganese for nickel in commercial steels.

The following structures are found in chromium-tungsten steels: Perlite, martensite, martensite and carbide, carbide with a background of γ iron, carbide with a background of sorbite.

In these steels the tungsten varies from 1 to 16 per cent, the chromium from 1 to 20 per cent, and the carbon from 0.1 to 1 per cent.

A small addition of tungsten to perlitic chromium steel does not affect the structure, but further additions result in the formation of martensite. With an excess of tungsten, troostite or sorbite are formed, and if the carbon present reaches 0.5 per cent a carbide is formed at the same time. If tungsten is added to martensitic chromium steel, no change is produced until a considerable quantity has been added. Then carbide is formed on a background of sorbite or γ iron.

The principal use for chromium-tungsten steels is in the manufacture of high-speed tools, for which purpose only the sorbitic (or troostitic) type is desirable. When this is subjected to definite heat treatment, the carbide present dissolves, and the mass takes on the structure of exceedingly fine-textured martensite almost invisible under the microscope. The heat treatment consists in raising the steel up to a temperature of 1,200° C., and keeping it there until all the carbide is dissolved. The rate of cooling apparently does not have any marked effect on the structure. The physical effect of this treatment is to make the steel very hard.

The perlitic chromium-tungsten steels are extremely hard and are rather brittle. They might be of value commercially in the manufacture of ball bearings and balls, but are not suitable for high-speed tools.

Martensitic steels are too difficult to forge and steels containing γ iron are too soft for high-speed tools.

Chromium-molybdenum and chromium-tungsten-molybdenum steels are also used for high-speed tools.

The following analysis shows the composition of a good quality tool steel: [a]

Analysis of high-speed tool steel.

C	0.55
Cr	3.50
W	13.50
Fe	82.45 (by difference)

[a] Gledhill, J. M., The development and use of high-speed tool steel: Jour. Iron and Steel Inst., No. 2, 1904, p. 127.

Ordinary carbon steel[a] containing about 1.20 per cent carbon becomes intensely hard when heated above the critical point and then rapidly cooled, but it gradually loses its hardness when the heat of friction, developed during cutting, reaches much above 500° F. High-speed steel, on the other hand, does not require quenching, although this adds somewhat to its hardness, and can stand friction temperatures up to 1,100° F. or even 1,200° F.

While carbon steels require quenching to make them hard, the mere presence of tungsten and molybdenum renders steel hard. Such steels do not require hastening of cooling more than is accomplished with the dry-air blast. The introduction of tungsten into chromium steel in which the percentage of chromium remains constant[b] (about 6 per cent) causes a gradual increase in hardness up to about 5.9 per cent, then a rapid increase in hardness up to about 9 per cent. Often this remains fairly steady up to about 14.5 per cent tungsten, and then another rise takes place at about 16.4, after which further addition of tungsten has no effect. The addition of chromium to tungsten steels, in which the tungsten remains constant (about 19 per cent) causes an increase of hardness up to about 5 per cent, after which there is a general decrease in hardness to about 8 per cent. The carbon content should not be over 0.9 per cent, or greater difficulty will be experienced in forging and the tools will be of inferior quality, probably because of brittleness in the mass.

A tool should have hardness and "red hardness," meaning by the latter term the ability to retain its hardness with an increase of temperature. The function of the chromium is to form a double carbide of tungsten and chromium (or molybdenum and chromium) which imparts to the steel a very high degree of hardness and increases the resistance to tempering.

High-speed tools fail at about 700° C. because of the formation of a new brittle constituent and not because of a loss of hardness or red hardness. Hardness assists red hardness by reducing the wear of the tool, thus reducing the formation of frictional heat.[c]

Chromite furnace linings.—Chromite brick[d] is generally made of crude chromite and coal tar, but sometimes of a mixture of chromite with kaolin, with bauxite, with milk of lime, or with other materials. It is being used to a considerable extent for furnace linings on account of its neutral character and refractory nature, and will doubtless be much more extensively used when its value becomes better known. These linings, together with those of basic magnesite brick, are gradually replacing linings of refractory acid bricks and highly aluminous silica brick in furnaces used for smelting lead, copper, antimony, and similar metals, the slag of which rapidly attacks and eats acid linings. Chromite has the advantage over magnesite in several particulars: (1) Magnesite is basic and is attacked by acid slags, while chromite is neutral and resists corrosion; (2) magnesite becomes soft when heated to high temperatures, while chromite

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[a] Gledhill, J. M., The development and use of high-speed tool steel: Jour. Iron and Steel Inst., No. 2, 1904, p. 127.

[b] Edwards, C. A., Function of chromium and tungsten in high-speed tool steel: Jour. Iron and Steel Inst., No. 2, 1908, p. 104.

[c] Further references on high-speed tool steels: Carpenter, H. C. H., The types of structure and the critical ranges on heating and cooling of high-speed tool steels under varying thermal treatment: Jour. Iron and Steel Inst., No. 1, 1905, p. 433; also Tempering and cutting tests of high-speed steels: Jour. Iron and Steel Inst., No. 3, 1906, p. 377.

[d] Havard, F. T., Use of refractory brick in metallurgy: Eng. and Min. Jour., Oct. 24, 1908.

retains a fair degree of hardness and is in general more resistant to abrasion; (3) chromite is able to stand sudden temperature changes without cracking; (4) magnesite requires more delicate handling than chromite. On account of these qualities, chromite would be preferred in all furnace work were it not for the fact that crude chromite ore is twice as expensive as burnt magnesite.

Chromite is generally used for furnace linings in the form of bricks which are held in place by tar mortar, but crushed chromite mixed with tar has been used. When heated, the tar burns away leaving a solid chromite lining. In some instances, irregular fragments of chromite have been hammered into place without the use of cementing materials.

In lead furnaces, chromite brick is desirable because a very refractory lining is necessary to withstand the corrosive action of the oxides of lead, antimony, and bismuth. In the softening furnace only that part of the walls with which the slag comes in contact is lined with refractory brick; in the cupelling furnace both roof and bottom should be of chromite or magnesite brick, because fire brick is attacked by lead fumes and a lead silicate is formed, which drops into the bath.

Chromite brick should also be used in reverberatory furnaces for smelting antimony, arsenic, bismuth, and tin, because the slags produced in the reduction of these metals are very corrosive and the oxides act as acids in attacking a basic lining, so that a neutral material is very desirable.

In the construction of the copper blast furnace, the walls of the jacket consist of ordinary red brick with a lining of fire brick. The walls of the crucible, however, should be lined with magnesite or chromite brick.

The most modern type of copper blast furnaces, viz, the water-jacketed steel cupola furnace, consists of steel or sheet copper walls cooled by water. The bottom or hearth is kept too cold by this process, chilling the slag and regulus. To remedy this, the bottom is lined with fire bricks to keep the molten material from the cold bottom. On account of the corrosive nature of the slag, fire-brick linings hardly ever last more than a week, and must then be renewed. The substitution for fire brick of fragments of chromite [a] hammered and fitted together compactly in the hearth has been found to be a very satisfactory method, the chromite lasting more months than fire bricks last days.

Chromite is also used for linings in reverberatory furnaces for copper with the same success.

Basic open-hearth furnaces [b] for the manufacture of steel are lined with chromite at points where the corrosive action is greatest. These furnaces generally consist of a basic hearth of calcined dolomite or burnt magnesite with the sides and roof of acid silica brick. Between these it is customary to put a layer of neutral material, chromite brick made of a mixture of chromite and coal tar being commonly used. On heating, this mixture burns into a firm, hard mass. Chromite is sometimes employed instead of magnesite for the hearth and is commonly used as a thin lining over the silica brick and other parts in the furnace exposed to the corrosive action of the slag or slag cinders.

[a] Glenn, Wm., Chromite as a hearth lining for a furnace smelting copper ore: Trans. Amer. Inst. Min. Eng., vol. 31, 1901, p. 374.

[b] Stoughton, B., The metallurgy of iron and steel, 1908, p. 139.

CHEMICAL USES.

Chrome pigments.—Chromium is a constituent in two varieties of coloring materials,[a] viz, pigments and dyes. The principal chromium pigments are chrome green, Guignet's green, chrome yellow, chrome orange, and chrome red.

Chrome greens have a light yellowish-green color. The basis is chromic oxide (Cr_2O_3). It is prepared by the precipitation of chromium hydroxide ($Cr(OH)_3$) from a solution of a chromic salt by soda, this product being washed and dried and then calcined at a red heat to expel the water.

Guignet's green is a chrome green consisting of hydrous chromic oxide prepared by heating a mixture of potassium bichromate and boric acid in a reverberatory furnace. A chromium borate is formed which is decomposed by water forming hydrous chromic oxide ($Cr_2O_3 2H_2O$), which generally contains a small amount of boric acid.

Chrome greens are sometimes made of chromium phosphate, prepared by boiling potassium bichromate with sodium phosphate and a reducing agent.

Chrome yellows consist of either lead chromate ($PbCrO_4$), zinc chromate ($Zn\ CrO_4$), or barium chromate ($Ba\ CrO_4$). Lead chromate is prepared by treating lead acetate or lead nitrate with potassium bichromate. It has a brilliant yellow color. For modified shades, lead, barium, or calcium sulphates are added, or a portion of the lead is precipitated as carbonate or sulphate by mixing the potassium bichromate with sodium carbonate or sulphate. Lead chromate is blackened by hydrogen sulphide and reddened by caustic alkali.

Zinc chromate has a lemon-yellow color and is prepared by treating zinc sulphate with neutral potassium chromate, or by boiling zinc oxide with potassium bichromate. It is decomposed by caustic alkali and dissolves in free acid.

Barium chromate has a greenish-yellow color, and is prepared from barium chloride and neutral potassium chromate.

Chrome orange and chrome red are prepared by boiling lead chromate (chrome yellow) with sodium or calcium hydroxide. This causes a precipitation of basic lead chromate ($Pb\ CrO_4\ PbO\ H_2O$) of orange or red color. Chrome red is also made by mixing white lead with a solution of neutral potassium chromate and boiling until the desired shade is developed. It is sold as Chinese red, American vermilion, or Victoria red.

Most chromium pigments are very permanent, mix well with oil and have good covering power.

Chrome dyes.—Three chromium colors are used as dyes: Chrome yellow, chrome orange, and chrome green.[a]

In dyeing cotton with chrome yellow, the cloth is first soaked in lime water and, after wringing, is soaked in a solution of lead acetate or nitrate. It is then returned to the bath of lime water and after wringing again is deposited in a solution of sodium or potassium bichromate to develop the color. After this it is passed through a dilute solution of hydrochloric acid and washed and dried.

Chrome orange is produced by treating cotton dyed with chrome yellow in a bath of lime water or alkali.

Chrome green is very pale and is not much used. It is formed by the deposition of chromic oxide in the fiber during the process of

[a] Thorp, F. H., Outlines of Industrial Chemistry, 1901, pp. 137, 203–209, 458, 493.

mordanting. On wool, it is formed by digesting the fiber in a strong solution of a bichromate and then passing it through a solution of sodium bisulphate.

Chrome mordants.—Chromium salts, including chromates and bichromates, are used as mordants in the dyeing and printing of cotton, linen, and wool. They act as oxidizing agents and are themselves reduced to chromic oxide (Cr_2O_3), which is fixed on the fiber. The goods are then ready to hold the desired dye.

In mordanting cotton and linen, sulphates, nitrates, acetates, bichromates, or alkaline chromium hydroxide are used. The material is soaked in a solution of chromium salt, dried, and passed through a boiling soda solution to fix the chromic oxide in the fiber. This process is repeated until the goods are sufficiently mordanted. In another process the goods are first prepared with tannin and Turkey-red oil and then soaked in the chromium solution. The fixing is done in cold lime water. In still another process the goods are steeped in basic chromium acetate and then fixed by steaming in a closed chamber.

Wool is mordanted with chromium fluoride, chrome alum, or bichromates (chromic acid). Tartrates and oxalic acid are generally used with these.

Potassium bichromate is the most useful mordant for wool. The goods are boiled in a solution of potassium bichromate for an hour or an hour and a half and, after being washed, are ready to hold the required dye. Oxalic acid or cream of tartar are generally added and reduce part of the bichromate to chromium hydroxide on the fiber. Chromed wool may be treated with sodium bisulphate to make the reduction more complete, for if the bichromate or chromic acid is not sufficiently reduced it frequently oxidizes the colors when dyed.

Chromium for oxidizing.—Potassium bichromate is used as an oxidizing agent in dyeing and making coal-tar dyes and as a bleaching agent for oils and fats.

Chromium for tanning.—Tanning with metallic salts[a] (usually of chromium or aluminum), known as "tawing," has become very important for light leathers such as glazed kid, calf kid, and glove leathers. When chromium is used, the process consists in depositing chromium oxide or hydroxide on the fibers of the skin which has been impregnated with a soluble chromium salt, usually potassium bichromate, though basic chromium chloride, chromium chromate, and chrome alum are also used.

After the skins have been limed, unhaired, and otherwise prepared they are worked into a solution of potassium bichromate to which some common salt (sodium chloride) has been added, together with one-fourth to three-fourths of the theoretical amount of hydrochloric or sulphuric acid necessary to liberate all the chromic acid (CrO_3). After several hours when the skin shows a uniform yellow color throughout, it is removed, and after the excess water is pressed out is worked in a bath of sodium bisulphite ($NaHSO_3$) or thiosulphate ($Na_2S_2O_3$) to which has been added some mineral acid to liberate the sulphur dioxide. The latter reduces the chromic acid deposited in the fiber during the first process to chromic oxide (Cr_2O_3). After the reducing and washing the skins are dyed with the desired color.

Chrome leather is tough and resists moisture very thoroughly.

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[a] Thorpe, F. H., op. cit.

CHROMIC IRON ORE INDUSTRY.

PRODUCTION.

The total production of chromite in the United States in 1908 was 359 long tons, valued at $7,230. Most of the ore was produced in Shasta County, Cal., and was used for linings in local furnaces. A small quantity came from Converse County, Wyo., and was shipped to Pueblo to be used also for furnace linings. No domestic ore was used in the manufacutre of chrome alloys, potassium bichromate, chrome paints, or other chemical materials.

The chromite industry began in the United States in 1827 with the discovery of chromic iron ore in the Bare Hills, Baltimore County, Md. Later ore was discovered in Cecil and Harford counties, Md., and still later in Lancaster, Chester, and Delaware counties, Pa. Between 1827 and 1880 large quantities of chrome ore were mined in Pennsylvania and Maryland, but the records of the production are very unreliable. The Wood mine in southern Lancaster County, Pa., is reported to have produced about 95,000 tons during this time, the Reed mine in Harford County, Md., about 100,000 tons, and the Bare Hills and Soldiers' Delight localities, Baltimore County, Md., about 5,000, a total of about 200,000 tons, which undoubtedly represents the greater part of the production before 1880. A small production has also been reported from a few places in North Carolina. The California deposits were discovered in the early seventies, but production did not commence much before 1880. The first ore was discovered in Del Norte County, and shortly after the San Luis Obispo County and Alameda County deposits were found. The chief producing counties have been San Luis Obispo, Shasta, Alameda, Del Norte, Placer, Glenn, and Tehama. Minor quantities have been produced in Napa, Sonoma, and Calaveras counties.

The following table shows the production of chromic iron ore in the United States as far as has been recorded. This entire product was obtained from California, with the exception of a small quantity (100 tons) from Maryland in 1885 and from Wyoming in 1908.

Production of chromite in the United States, 1880–1908, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1880	2,288	$27,808	1895	1,740	$16,795
1881	2,000	30,000	1896	786	6,667
1882	2,500	50,000	1897	.....	.....
1883	3,000	60,000	1898	.....	.....
1884	2,000	35,000	1899	.....	.....
1885	2,700	40,000	1900	140	1,400
1886	2,000	30,000	1901	368	5,790
1887	3,000	40,000	1902	315	4,567
1888	1,500	20,000	1903	150	2,250
1889	2,000	30,000	1904	123	1,845
1890	3,599	53,985	1905	22	375
1891	1,372	20,580	1906	107	1,800
1892	1,500	25,000	1907	290	5,640
1893	1,450	21,750	1908	359	7,230
1894	3,680	53,231			

PRICES.

The price of chrome ore varies from $10 to $20 per long ton, according to the grade of the ore. Imported ore from New Caledonia carrying 50 per cent chromic oxide is quoted in New York at $17.50 to $20 per long ton, excluding cost of transportation. When the chromic oxide exceeds 50 per cent, the value of the ore rises in proportion;

when the chromic oxide is less than 50 per cent, the value of the ore decreases at a more rapid rate. The California ore is valued at $20 per short ton at the mines.

The price of chrome bricks, f. o. b. Pittsburg, is $175 per M.

Potassium bichromate was sold at $0.08⅝ to $0.09 per pound during the latter part of 1908.

IMPORTS.

During the last five or six years important quantities of chrome ore have been imported from New Caledonia, Greece, Canada, Great Britain, Asiatic Turkey, and Japan, and minor quantities from European Turkey, Belgium, Germany, France, Cuba, Australia, Tasmania, New Zealand, and Portuguese Africa. The chrome ores imported in 1908 were obtained largely from New Caledonia, Greece, Canada, Great Britain, and Portuguese Africa.

Canada produced 7,225 short tons of chromite, valued at $82,008, in 1908, as compared with 7,196 tons, valued at $72,901, in 1907. Of the 1908 product 4,571 tons were exported—most, if not all, of it going to the United States.

The following table shows the imports of chrome ore and various manufactured chromium products into the United States as far as has been recorded:

Chromate and bichromate of potash, chromic acid, and chrome ore imported and entered for consumption in the United States, 1867 to 1908, inclusive.

Year ending—	Chromate and bichromate of potash.		Chromic acid.		Chrome ore.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
June 30—	*Pounds.*		*Pounds.*		*Long tons.*		
1867	875,205	$88,787					$88,787
1868	777,855	68,634					68,634
1869	877,432	78,288		$3			78,291
1870	1,235,946	127,333		8			127,341
1871	2,170,473	223,529		5			223,534
1872	1,174,274	220,111	514	49			220,160
1873	1,121,357	178,472	922	276			178,748
1874	1,387,051	218,517	44	13			218,530
1875	1,417,812	183,424	45	22			183,446
1876	1,665,011	175,795	120	45			175,840
1877	2,471,669	264,392	13	10			264,402
1878	1,929,670	211,136	32	35			211,171
1879	2,624,403	221,151					221,151
1880	3,505,740	350,279	5	3			350,282
1881	4,404,237	402,088	124	89			402,177
1882	2,449,875	261,006	52	42			261,048
1883	1,990,140	208,681	290	338			209,019
1884	2,593,115	210,677		120	2,677	$73,586	284,383
1885	1,448,539	92,556		39	12	239	92,834
December 31—							
1886	1,985,809	139,117		101	3,356	43,721	182,939
1887	1,722,465	120,305		5,571	1,404	20,812	146,688
1888	1,755,489	143,312		281	4,440	46,735	190,328
1889	1,580,385	137,263		2,974	5,474	50,782	191,019
1890	1,304,185	113,613		634	4,353	57,111	171,358
1891	755,254	55,897	634	203	4,459	108,764	164,864
1892	496,972	94,055	772	204	4,930	55,579	149,838
1893	976,706	78,981	3,708	641	6,354	58,629	138,251
1894	1,483,762	125,796	5,680	837	3,470	38,364	164,997
1895	2,045,910	181,242	2,083	414	5,230	82,845	264,501
1896	952,794	80.538	2,429	387	8,669	187,400	268,325
1897	1,329,473	108,497	71,220	5,457	11,570	187,439	301,393
1898	1,160,710	86,134	5,329	1,758	16,304	272,234	360,126
1899	1,130,965	73,510	33,134	6,360	15,793	284,825	364,695
1900	111,761	7,758	35,452	7,232	17,542	305,001	319,991
1901	430,996	29,224	53,462	10,861	20,112	363,108	403,193
1902			90,817	11,115	39,570	582,597	593,712
1903	41,229	2,784	57,799	5,465	22,932	302,025	310,274
1904	26,053	1,817	87,721	10,505	24,227	348,527	360,849
1905	59,650	4,225	38,555	4,657	54,434	725,301	734,183
1906	30,098	2,124	1,307	331	43,441	557,594	560,049
1907	18,171	1,307	1,834	403	41,989	491,925	493,635
1908	216,081	15,453	3,805	708	27,876	345,960	362,121

OCCURRENCE OF CHROMIC IRON ORE.

MASSACHUSETTS.

Chromite occurs disseminated through the serpentine phases of the Chester amphibolite in western Massachusetts.[a] There has been considerable exploration in Middlefield township in Hampshire County, and Blandford Township in Hampden County, both near the Berkshire County boundary, but no ore bodies of commercial importance have been found.

PENNSYLVANIA AND MARYLAND.

In the gneissic area of southern Pennsylvania and northern Maryland there are numerous local areas or bands of serpentine scattered through a northeast-southwest belt extending from Delaware County, Pa., southwestward through Chester and Lancaster counties, Pa., and Cecil, Harford, and Baltimore counties, Md. These serpentine areas locally contain an abundance of chromite as disseminated crystals and in a few places as extensive lenticular bodies. By the disintegration of the serpentine and ore bodies, the chromite is liberated and collected as chrome sand and gravel deposits along streams and in ravines. Both the solid lenses and the fluviatile deposits have yielded considerable ore. The principal deposits mined were in southeastern Lancaster County, Pa., near the state line in Harford County, Md., and in western Baltimore County, Md.

Chromite occurs in Delaware County[b] near Fawkes Run and Newton townships, near Palmer's Mill and other localities, Marple Township, and near Blue Hill, Upper Providence Township. The ore is found in local areas of serpentine associated with schist, and commonly occurs in lenticular bodies and in disseminated grains. At many localities sand and gravel deposits are found, formed through the disintegration of the serpentine, and several of these have been mined.

The chromite of Chester and Lancaster[c] counties, Pa., and Cecil and Harford counties, Md.,[d] occurs in an elongated east-west area of serpentine on the boundary between Pennsylvania and Maryland, which extends southwestward into the latter State. A portion of the area is in the southern part of Chester and Lancaster counties, Pa., and a portion is in Cecil and Harford counties, Md. This area contained deposits of chromite which were at one time the most important in the United States, but which have not been mined for many years. They consisted of both sand chrome deposits along streams and solid lenticular bodies in serpentine. The principal mines were in southeastern Lancaster County, Pa., but numerous small deposits were mined throughout the serpentine area.

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[a] Emerson, B. K., Holyoke folio (No. 50), Geol. Atlas U. S., U. S. Geol. Survey, 1898.

[b] Hall, C. E., Field notes in Delaware County: Pennsylvania Second Geol. Survey, Rept. C^5, pp. 35, 53, 55, and 60.

[c] Genth, F. A., Mineralogy of Pennsylvania: Pennsylvania Second Geol. Survey, Rept. B, pp. 39–43. Frazer, P., jr., Geology of Lancaster County: Pennsylvania Second Geol. Survey, Rept. CCC, pp. 192–196. Rogers, H. D., Frazer, P., jr., Hall, C. E., Geology of Chester County: Pennsylvania Second Geol. Survey, Rept. C^4, pp. 92 and 93.

[d] Mathews, E. B., The mineral resources of Cecil County: Maryland Geol. Survey, Cecil County, p. 221; also Cecil County atlas and Harford County atlas, Maryland Geol. Survey, and Maryland Geological Survey, vol. 1, 1897, p. 226.

The first deposits discovered in this belt were the Reed mine in Harford County, Md., about 27 miles northeast of Baltimore. This occurred about 1827, and soon after the Wood mine in Lancaster County, Pa., and others were found.

The Wood mine [a] was the largest and most important of the mines. It was opened in 1828 and was operated until 1881 with the exception of five years from 1868 to 1873, when it was flooded with water. After 1881 the California and Turkish mines came into prominence and chrome mining practically ceased in eastern United States with the exception of a few chrome sand operations which continued to about 1900. The Wood mine is in a bend of the Octoraro Creek near Horse Shoe Ford in the southern part of Little Britain Township, Lancaster County. The deposit consisted of a large lenticular mass of chromic iron ore with serpentine walls. It had an average width of about 20 feet, generally ranging between 10 and 35 feet, though frequently pinching out altogether. In this space occurred ore and gangue, the latter consisting largely of magnesite and serpentine. The deposit had a maximum length of 300 feet and at the time of the cessation of operations had been tested to a depth of 720 feet. The strike of the ore body is about N. 78° E. at the outcrop, but is nearly north and south in the lower levels. It dips from 40° to 60° NW. The average content of chromic oxide of the ores was about 48 per cent, though picked samples yielded as high as 56 per cent. Small quantities of chrome sand, containing about 46 per cent chromic oxide, were also obtained in the vicinity of the Wood mine.

About 3 miles west of the Wood mine, on the boundary between Lancaster County, Pa., and Cecil County, Md., was the Low mine (Line pit), which also operated a lenticular ore body in the serpentine, and south from this to Rock Springs, Md., there were a series of small deposits. Besides these there were many small mines elsewhere in the serpentine belt, some of which operated solid bodies, but the majority of which consisted of temporary pits and trenches from which chrome sand was taken. The most important of the latter occurrences were in Elk, East Nottingham, and West Nottingham townships, Lancaster County, and in the western part of Cecil County, Md. One of the most recently operated mines in northern Cecil County was the Tweed chrome mine, [b] about 2 miles northwest of Sylmar Station and 3 miles southeast of the Wood mine. The ore was chrome sand, which occurred with siliceous sand and gravel along a small water course. The deposit was worked to a depth of 4 or 5 feet. The country rock is serpentine, in which grains of chromite and magnesite are disseminated locally. The mine was in operation in 1899, but was soon after abandoned, and since then no chrome ore has been mined in eastern United States.

The Baltimore County, Md., deposits occur at the southwestern end of the Pennsylvania-Maryland serpentine belt. The principal deposits occur in the western part of the county, in Green Spring Valley, at Bare Hills, Soldiers Delight, near Owings Mills, about 16 miles northwest of Baltimore. All of these deposits consisted of chrome sand interstratified with the alluvial material. They were at one time the most important chrome deposits in the State.

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[a] Frazer, P., jr., Geology of Lancaster County: Pennsylvania Second Geol. Survey, Rept. CCC, pp. 192–196

[b] Engineering and Mining Journal, A Chrome Ore Mine: Issue of Aug. 5, 1899, vol. 68, p. 161.

NORTH CAROLINA.

Numerous occurrences of chromite are known in Watauga, Yancey, Madison, Buncombe, and Jackson counties, in western North Carolina, in association with local areas of dunite. While for the most part ore occurs in small grains disseminated through the dunite, a few deposits of commercial importance have been found. The principal deposits are at the following localities: [a]

Seven miles northwest of Boone, Watauga County; 4 miles north of Burnsville, Yancey County; 6 miles east of Burnsville, Yancey County; 6 miles southwest of Burnsville, Yancey County; 3 miles northeast of Stocksville, Buncombe County; 1½ miles north of Democrat, Buncombe County; half a mile west of Democrat, Buncombe County; near Webster and Balsam Gap, Jackson County.

The chromite in general occurs in two forms, viz, as small grains disseminated through the dunite and as balls and nodules of various sizes. Only the second type is of importance as an ore. Most of the bodies are only a few inches in diameter, but a few larger deposits have been found. One of these occurring north of Burnsville was 3 feet in its greatest diameter, while another southwest of Burnsville contained several tons of ore.

West of Democrat the ore consists of streaks and narrow bands of chromite crystals so grouped in the dunite as to form a kind of vein. This chromite-bearing zone is 4 to 8 feet wide. Chromite sand is associated with it as a surface deposit, and indicates by its extent that the vein is probably half a mile in length in a northeast-southwest direction.

The following description of the North Carolina chromite deposits is given by Pratt and Lewis: [b]

> Although prospecting for chrome ore in this State was undertaken over thirty years ago and has been conducted spasmodically ever since, there has never been any systematic development of the localities.
>
> In the alluvial deposits at the base of the peridotite outcrops there is usually a considerable amount of chromite in crystals and particles, but nowhere have they been observed in sufficient quantity to constitute a chrome sand ore.
>
> The chrome ore is nearly uniform in general character throughout the entire area, being very hard and compact, though often of a fine granular appearance, and there is but little that is at all friable. Masses of chromite are usually very free from seams of peridotite or its alteration products. This simplifies the concentration, and a high-grade ore can usually be obtained by cobbing and hand picking.
>
> In the following descriptions of localities only those are mentioned in which chromite occurs otherwise than in grains or small nodules, and full description is given only of those localities in which ore is found in some quantity.
>
> Nitze mentions the occurrence of chromite in small pockets or seams in the drainage basin of Cove Creek, Watauga County, 7 miles northwest of Boone. On the farm of David Lawrence a pocket of chromite was opened and yielded about 10 tons of ore. When this pocket had been exhausted, no further prospecting was undertaken. [c]
>
> In Yancey County one of the two most important deposits in the State occurs at Mine Hill, on the Mine Fork of Jack Creek, 5 miles north of Burnsville, the county seat, on the Bakersville road, where a large peridotite (dunite) formation outcrops on both sides of the road. Seams or pockets of chromite ore are abundant in this peridotite, varying from 0.5 inch to 3 inches in thickness. Near the summit of the hill, on the east side of the road, about 150 feet above the road and stream bed, a deposit of

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[a] Pratt, J. H., and Lewis, J. V., Corundum and the peridotites: North Carolina Geol. Survey, vol. 1, 1905, pp. 381-384. Nitze, H. B. C., Iron ores: Bull. North Carolina Geol. Survey No. 1, 1893, pp. 212-215, Keith, A., Asheville folio (No. 116), Geol. Atlas U. S., U. S. Geol. Survey, 1904; also Mount Mitchell folio (No. 124), Geol. Atlas U. S., U. S. Geol. Survey, 1905.

[b] Pratt, J. H., and Lewis, J. V., Corundum and the peridotites: North Carolina Geol. Survey, vol. 1, 1905, pp. 381-384.

[c] Nitze, H. B. C., Iron ores: Bull. North Carolina Geol. Survey No. 1, 1893, pp. 212-215.

chromite has been opened from which 25 tons of ore were taken, a large part of which still remains on the dumps. A pit 9 feet deep was sunk in the deposit, but this has been filled with water since the work ceased, so that no estimate can be made of the extent of the deposit. Garret Ray, of Burnsville, N. C., the owner, reports that the chromite widened to between 2 and 3 feet at the bottom of the pit. There are other promising seams or veins which appear to indicate the existence of a deposit of chromite ore near the contact of the peridotite and gneiss.

On the west side of the road the peridotite formation rises in another hill, and here there are numerous small seams and pockets of chromite. On the extreme western slope of the formation a trench has been cut 100 feet or more into the hill, in which are exposed many small pockets of chromite.

With the exception of the pit sunk near the summit of Mine Hill, from which a few tons of ore were shipped, no mining has been done here, and very little prospecting has been undertaken to determine the exact extent of the chromite deposits.

An analysis of a selected specimen of the chromite gave the following results:

Analysis of selected specimen of chromite from Mine Hill, 5 miles north of Burnsville, Yancey County.

Cr_2O_3	58.00	MgO	8.26
Al_2O_3	15.52	SiO_2	3.20
FeO	14.45	CaO	.70

Baskerville, analyst.

About 9 miles west of Burnsville, near Price Creek, there is a narrow bed of peridotite on the land of W. A. Robertson, a quarter of a mile from Price Creek post-office. A pocket of chromite discovered here yielded nearly 7 tons of ore. This exhausted the pocket, and since then no prospecting has been done in this vicinity.

An analysis of a selected sample of this ore gave the following result:

Analysis of selected sample of chromite from Price Creek, 9 miles west of Burnsville, Yancey County.

Cr_2O_3	59.20	MgO	4.42
Al_2O_3	7.15	SiO_2	3.20
FeO	25.02	MnO	.92

Baskerville, analyst.

In Jackson County, in the vicinity of Webster, there is a large peridotite (dunite) formation extending from about half a mile north of the town to a mile and a quarter south. The widest part of the area, about half a mile, is at Webster, the town being partly built on the dunite hill. Tuckaseegee River cuts through this formation about half a mile below the town. Considerable prospecting has been carried on in this region and numerous veins and pockets of chromite of varying extent have been discovered.

The only deposit of any note found on the north, or Webster, side of the river is on the east side of the Tuckaseegee road, about 200 yards from the main street of the town, on the land of Daniel Schneider. A pocket of chromite was uncovered here which yielded a number of tons of chromite, most of which was shipped. At a depth of nearly 9 feet the pocket pinched out, leaving but a small seam of chromite in sight. Many small seams and pockets of chromite are to be seen, but no other work has been undertaken for chromite on the north side of the river.

On the south side of the river, following closely the contact of the dunite with the gneiss, a line of prospect pits has been dug, which show the presence of a considerable amount of chromite. The prospecting has been done on the lands of Joseph Hooker, Lawrence Buress, Alf Wilson, James Ashe, and Daniel Fullbright, all of Webster, N. C. The most promising deposits are on the land of James Ashe, where a cut 25 feet long, 6 to 8 feet wide, and 8 to 10 feet deep was sunk on a vein of chromite 12 to 18 inches thick, which at the bottom of the cut is 12 inches thick; and another on the land of Daniel Fullbright, where a seam nearly 12 inches thick is exposed in the branch. The nearest shipping point is Sylva, on the Southern Railway, 3 miles north of Webster.

Chromite has been found at a number of places in the masses of peridotite within 2 to 3 miles southwest from Balsam Gap, Jackson County. The most promising outlook for a large deposit is on Dark Ridge Creek, about 525 feet south of the Dark Ridge trestle of the Murphy branch of the Southern Railway. On the east side of the creek a cut 18 feet deep and 10 feet wide was made on the pocket of chromite,

from the bottom of which two seams of chromite, 6 and 8 inches thick, respectively, extended. Fifteen tons of ore were taken out of the main pocket. About 200 yards farther south, on the opposite side of the creek, a shallow pit was sunk which encountered considerable chromite. Both these openings were near the contact of the peridotite and gneiss. Between these and in their vicinity there is a large quantity of float ore. These facts point to this locality as one worthy of further development, with an expectation of finding a large quantity of ore. Its proximity to the railroad is also a great advantage. Analyses show the ore to carry about 49 per cent of Cr_2O_3. The property is owned by the Highland Forest Company, of Waynesville, N. C.

No large deposits of chromite have yet been found in North Carolina, but the work done shows that extensive deposits may exist in the State, those described above being the most promising known.

WYOMING.

An important deposit of chromite has been recently opened in Deer Creek Canyon, in the western part of Converse County, Wyo., about 15 miles southwest of Glenrock.[a] The ore body occurs in serpentine along the wall of a box canyon about 1,000 feet in depth on the northern slope of the Laramie Hills. The ore body is in the form of a lens dipping at a steep angle into the canyon wall and striking parallel to the canyon. The highest part of the outcrop is about 400 feet from the bottom of the canyon. The ore body has a length of about 600 feet and a maximum width of about 110 feet. In this width, however, there are included several layers of serpentine, which separate the deposit into four or five smaller lenses, the largest of which has a width varying from 12 to 20 feet. The combined width of the different ore lenses is about 40 feet. The ore is dense and fine grained and has a greenish-black color. It contains an average percentage of 35 per cent Cr_2O_3 and 17 per cent FeO.

The ore is hauled by wagon to Glen Rock, where it is loaded on cars. The deposit was discovered in the summer of 1908 and operations were begun soon after.

CALIFORNIA.

Serpentine and associated igneous rocks occur throughout both the Sierra Nevada and the Coast Range, California.[b] They are found in local areas of greater or less extent, and chromite occurs widely distributed through them. Chromite is known in at least twenty-five counties, among which the most important are Alameda, Amador, Butte, Calaveras, Del Norte, Eldorado, Fresno, Glenn, Mendocino, Napa, Placer, Plumas, San Benito, San Luis Obispo, Santa Clara, Shasta, Sierra, Sonoma, Siskiyou, Tehama, Trinity, and Tuolumne. The largest and most important chromite deposits in the State are those in Shasta and San Luis Obispo counties. Those of Alameda, Santa Clara, Del Norte, Calaveras, Placer, Eldorado, Glenn, and Tehama counties are of minor extent. The following are short descriptions of the known deposits:

Shasta County.—The deposits of Shasta County are the only ones which are at present operated in California. The principal occurrences are on Shot Gun Creek.[c] One mile from the Southern Pacific

[a] This description was kindly furnished the author by Mr. E. W. Merritt, president Chromium Mines Company, of Denver.

[b] Ann. Rept. State Mineralogist, No. 4: California State Min. Bur., 1882–1884.
Idem, No. 6, 1885–1886.
Idem, No. 8, 1888.
Idem, No. 10, 1890.
Idem, No. 11, 1892.
Idem, No. 12, 1894.
Idem, No. 13, 1895–96.
The structural and industrial materials of California: Bull. California State Min. Bur. No. 38, pp. 266–272.

[c] Diller, J. S., Redding folio (No. 138), Geol. Atlas U. S., U. S. Geol. Survey, 1906.

Railroad, in the western part of Shasta County, a series of five lenticular beds or deposits ranging from 200 to 1,500 tons each, connected by more or less distinct veinlike stringers, occur in serpentine along a somewhat indefinite shear zone which is nearly vertical and trends S. 40° W. With the exception of the stringers connecting the deposits there is nothing in the ore masses to suggest vein structure. The deposits are all within a distance of 250 yards and have not been worked to any great depth. Parallel zones of ores have been found in the same region, but are not as yet productive. The ore generally separates easily from the serpentine, but in some cases it adheres firmly. The following analysis shows the composition of the ore:

Analysis of chromic iron ore, Shasta County, Cal.

Cr_2O_3	43.87
FeO	15.86

San Luis Obispo County.—Numerous and large bodies of chromite occur in the serpentine areas of San Luis Obispo County, along the southwestern slope of the Santa Lucia range, northwest of San Luis Obispo. Small deposits of chromite occur in the San Luis range southwest of San Luis Obispo.

Most of the deposits along the Santa Lucia Mountains occur in the vicinity of a fault zone. The following description of the deposits is given by Fairbanks:[a]

"The ore (in the Santa Lucia range) is in the form of irregular, more or less disconnected veins and bunches along fissured zones in the serpentine through which mineral-bearing waters have percolated. All stages of replacement of serpentine by the chromite are exhibited from that in which the ore appears as granules scattered through the porous serpentine to that in which it forms massive bunches many tons in weight. In the Pick and Shovel mine one mass weighing 1,000 tons is reported to have been discovered. In the vicinity of some of the mines much float ore is scattered over the surface, and some attempt has been made at concentrating it. The workings have so far been superficial and the deposits are not much more than touched."

The group of mines southwest of San Luis Obispo also consists almost entirely of surface workings, which consist in following up irregular stringers and bunches of ore.

Fairbanks's theory that the ores were deposited by percolating waters is at variance with the ideas of other investigators of chromite deposits, who believe that these ores are largely the result of magmatic segregation.

No mining has been done in San Luis Obispo County in recent years because of the low price paid for chrome ore, but large quantities of ore are in sight.

Alameda County.[b]—Small quantities of chromic iron ore have been found in Alameda County southeast of Livermore. The principal deposits are at the Douglas and Mendenhall mines, on Cedar Mountain, 15 miles southeast of Livermore, and at the Jones mine, 20 miles southeast of Livermore, on the Arroyo Mocha road. The ore occurs in serpentine in small irregular bodies and lenses. The deposits are irregular in thickness and depth and apparently occur in crushed and broken portions of the serpentine.

[a] Fairbanks, H. W., San Luis folio (No. 101), Geol. Atlas U. S., U. S. Geol. Survey, 1904.
[b] The structural and industrial materials of California: Bull. California State Min. Bur. No. 38, p. 266.

Santa Clara County.[a]—A large body of chromite several feet in width occurs in bluish decomposed serpentine on the Hahn ranch, in Santa Clara County. Other deposits are reported at Greenwall's mine, in the foothills west of the Southern Pacific Railroad, 16 miles south of San Jose,[b] at Los Gatos,[c] and elsewhere.

Del Norte County.[d]—Large deposits of chromite are found embedded in serpentine in Rattlesnake Mountain, from Bald Hill to Klamath River. Other deposits occur at the French Hill mines, 3 miles south of Gasquet, as kidneys embedded in serpentine, and at the Low Divide mine, 8 miles east of Smith River post-office and 20 miles from Crescent City.

Eldorado, Amador, and Calaveras counties.—Numerous small deposits of chrome ore occur along the serpentine belt passing through southwestern Eldorado County,[e] west and southwest of Placerville and southeastward into Amador and Calaveras counties.[f] The principal bodies occur in Eldorado County, about 6 miles northwest of Plymouth, and in Calaveras County, about 5 miles north of Valley Springs, near the Mokelumne River, and 7 miles north of Milton, on the west slope of the Bear Mountains. Other deposits are reported from the vicinity of Camp Seco and Murphy, Calaveras County,[g] near Jackson, and Mountain Spring House, Amador County, and in Eldorado County, 10 miles west of Shingle Springs, near Latrobe, and on the south fork of the American River east of Folsom City.[h]

Plumas County.—Bodies of chromic iron ore occur in serpentine in west-central Plumas County,[i] 2 miles west of Spanish Ranch and south of Clear Creek, about three-fourths of a mile southwest of Meadow Valley. Pebbles of chrome ore occur in the Pleistocene conglomerate of Meadow Valley and in auriferous gravels elsewhere.

Placer County.—Small irregular masses of chromite occur in serpentine and peridotite in Placer County[j] near Green Valley, in the North Fork of the American River below Towle, on the Forest Hill divide near Forest Hill, and in the serpentine area of Flagstaff Hill,[k] about 9 miles south of Auburn.

Other deposits are reported from localities 7 miles east of Iowa Hill, near Alabaster Cave, at Michigan Bluffs, near Auburn,[l] near Weimar, and near Cape Horn. The first two of these have been worked quite extensively. Surface deposits have been worked in the serpentine belt extending north from Ladies Canyon to Rattlesnake Den, near Dutch Flat.[m]

Sierra County.—Pebbles of chromite occur along Goodyear Creek and at Howland Flat 3 miles west and 10 miles north-northwest, respectively, from Downieville, Sierra County.[n] They were probably derived from neighboring serpentine areas. A large deposit of mag-

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[a] Ann. Rept. State Mineralogist No. 12: California State Min. Bur., 1894, p. 38.
[b] Ann. Rept. State Mineralogist No. 13: California State Min. Bur., 1895–96, p. 50.
[c] Ann. Rept. State Mineralogist No. 4: California State Min. Bur., 1883–84, p. 136.
[d] Structural and industrial materials of California: Bull. California State Min. Bur. No. 38, pp. 267–268.
[e] Lindgren, W., and Turner, W. H., Placerville folio (No. 3), Geol. Atlas U. S., U. S. Geol. Survey, 1894.
[f] Turner, W. H., Jackson folio (No. 11), Geol. Atlas U. S., U. S. Geol. Survey, 1894.
[g] Structural and industrial materials of California: Bull. California State Min. Bur. No. 38, p. 267.
[h] Ann. Rept. State Mineralogist No. 4: California State Min. Bur., 1883–1884, p. 136.
[i] Turner, W. H., Bidwell Bar folio (No. 43), Geol. Atlas U. S., U. S. Geol. Survey, 1898.
[j] Lindgren, W., Colfax folio (No. 66), Geol. Atlas U. S., U. S. Geol. Survey, 1900.
[k] Lindgren, W., Sacramento folio (No. 5), Geol. Atlas U. S., U. S. Geol. Survey, 1894.
[l] Ann. Rept. State Mineralogist No. 4: California State Min. Bur., 1883–1884, p. 137.
[m] Structural and industrial materials of California: Bull. California State Min. Bur. No. 38, p. 268.
[n] Turner, W. H., Downieville folio (No. 37), Geol Atlas U. S., U. S. Geol. Survey, 1897.

nesian chromite is reported from southwestern Sierra County, near Camptonville.[a] Other deposits are reported from Mountain House, near Downieville and southeast of Brandy City.[b]

Tuolumne County.—Loose masses of chromite occur in the serpentine northwest of Mountain Pass, about 8 miles southwest of Sonora, Tuolumne County.[c] Outcrops 4 feet in thickness occur at the Engel mine at York Tent, near Chinese Camp.[d]

Tehama County and Glenn County.—A belt of serpentine with a general north and south trend runs through the southwestern part of Tehama County and the northwestern part of Glenn County, on the lower slopes of North Yolla Bolly Mountains, a spur of the Coast Range. Chromite float is found at a large number of places along this belt, but mining operations have been conducted only on the north fork of Elder Creek in Tehama County and at the Black Diamond mine in Glenn County west of Newville.[e] The former locality has yielded a large quantity of ore which averaged about 47 per cent chromic oxide. The Glenn County locality also has produced considerable ore.

Butte County.—A large kidney of chromite from 10 to 100 feet wide is reported in serpentine in western Butte County, north of Forbestown.[f]

Mendocino County.—Chromite of good quality is reported from several localities in the hills west of the Russian River valley. The individual deposits are small but numerous.[g]

Sonoma County.—Deposits of chromite are reported from localities 3 miles west of Geyersville and 3 miles south of Cloverdale, Sonoma County.[h] Considerable ore has been shipped from the last-named locality. Other deposits are reported from Litton Springs, Hoods ranch,[i] and Sonoma Switch.[k]

Siskiyou County.—Chromite float is found near the top of the Forest Mountains in serpentine areas southwest of Yreka and in the vicinity of the Dewey mine, 10 miles southwest of Gazelle, Siskiyou County.[k]

Trinity County.—Chromite is reported on the north fork of the east fork of Trinity River and from the vicinity of Hayfork.[l]

Fresno County.—Chromite occurs in a serpentine belt 6 miles southwest of Toll House,[m] near Sentinel, in northern Fresno County. Considerable ore has been mined here.

San Benito County.—Deposits are reported from Emmett in the central part New and from Idria in the southeastern part of San Benito County.[n] At the latter locality large deposits are said to occur in serpentine.

Napa County.—Chromite is reported from Pope and Chiles valleys in the range east of St. Helena, Napa County.[o]

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[a] Structural and industrial materials of California: Bull. California State Min. Bur. No. 38, p. 271.
[b] Ann. Rept. State Mineralogist No. 6: California State Min. Bur., 1885–1886, p. 101.
[c] Turner, W. H., and Ransome, F. L., Sonora folio (No. 41), Geol. Atlas U. S., U. S. Geol. Survey, 1897.
[d] Ann. Rept. State Mineralogist No. 4: California State Min. Bur., 1883–1884, p. 138.
[e] Structural and industrial materials of California: Bull. California State Min. Bur. No. 38, pp. 268, 272.
[f] Structural and industrial materials of California: Bull. California State Min. Bur. No. 38, p. 267.
[g] Op. cit., p. 268.
[h] Ann. Rept. State Mineralogist No. 13: California State Min. Bur., 1895–1896, p. 50.
[i] Ann Rept. State Mineralogist No. 4: California State Min. Bur., 1883–1884, p. 137.
[j] Ann. Rept. State Mineralogist No. 12: California State Min. Bur., 1894, p. 38.
[k] Structural and industrial materials of California: Bull. California State Min. Bur. No. 38, p. 272.
[l] Idem.
[m] Op. cit., p. 268.
[n] Op. cit., p. 269; also Ann. Rept. State Mineralogist No. 4: California State Min. Bur., 1883–1884, p. 136.
[o] Ann. Rept. State Mineralogist No. 13: California State. Min. Bur., 1895–1896, p. 49.

Marin County.—On the Maillard ranch, 7½ miles west of San Rafael, there are said to occur several small bunches of chromite in serpentine[a].

Lake County.—Chromic iron ore occurs in several large veins in Jerusalem Valley, 8 miles east of Middletown, and near the Bradford mine,[b] in serpentine. Other occurrences are reported from Lower Lake and Glenbrook.[c]

Tulare County.—Chromite is reported from Deep Creek, near Plano, and from a locality 10 miles from Portersfield, Tulare County.[d]

Santa Barbara County.—A few tons of chromic iron ore have been mined about 10 miles north of Santa Ynez.[e]

Santa Cruz County.—Chromite occurs in a few spots in Santa Cruz County.[f]

Monterey County.—Chromite occurs in Monterey County near the San Benito River.[g]

Nevada County.—Chrome ore is reported from Nevada County 2 or 3 miles from Nevada City,[h] and from Deer Creek and Coyote Diggings.[c]

San Francisco and San Mateo counties.[d]—Unimportant bodies of chrome ore have been found on the San Francisco peninsula, and in San Mateo County.

Solano County.—Chromite has been found near Fairfield, Solano County.[d]

Los Angeles County.—Chromite occurs with magnetite as sand near Langs Station, Soledad Canyon, Los Angeles County.[c]

OREGON AND WASHINGTON.

Chromite occurs in some abundance in the black sands[i] along the seacoast and the larger rivers on the Pacific slope, especially in Oregon. These sands consists of quartz with an admixture of magnetite, ilmenite, chromite, garnet, hypersthene, olivine, monazite, zircon, gold, and platinum. The predominance of the heavy basic minerals gives them a black color and high specific gravity.

FERROCHROMIUM.

No record has been kept of the production of ferrochromium in the United States.

Ferrochromium is generally made in two qualities:[j] (1) Containing from 60 to 70 per cent chromium and 0.30 to 0.75 per cent carbon; and (2) containing from 60 to 70 per cent chromium and from 1 to 2 per cent carbon. The alloy containing the lower percentage of carbon sells at from $700 to $730 per ton; the other alloy sells at from $435 to $460 per ton. The chief producer of ferrochromium is the Société Anonyme Électrométallurgique Girod, at Ugines, France.

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[a] Ann. Rept. State Mineralogist No. 12: California State Min. Bur., 1894, p. 37.
[b] Ann. Rept. State Mineralogist No. 8: California State Min. Bur., 1888, p. 326.
[c] Ann. Rept. State Mineralogist No. 6: California State Min. Bur., 1885–1886, p. 100.
[d] Op. cit., p. 101.
[e] Ann. Rept. State Mineralogist No. 12: California State Min. Bur., 1894, p. 37.
[f] Ann. Rept. State Mineralogist No. 11: California State Min. Bur., 1892, p. 49.
[g] Ann. Rept. State Mineralogist No. 4: California State Min. Bur., 1883–84, p. 136.
[h] Op. cit., p. 127.
[i] Day, David T., and Richards, R. H. Useful minerals in the black sands of the Pacific slope: Mineral Resources U. S. for 1905; U. S. Geol. Survey, 1906, p. 1228.
[j] Kershaw, J. B. C. Progress in the electric steel and ferro-alloys industries: Iron Trade Rev., Nov. 5, 1908, p. 760.

TIN.

By Frank L. Hess.

PRODUCTION.

The only tin ore produced in this country during the year 1908 was a few tons of stream tin sluiced from gravels in Seward Peninsula, Alaska, as described more fully in the following paragraphs.

Alaska.—The American Tin Mining Company produced a few tons of stream tin from Buck Creek. The ore, which was taken out while assessment work was being done, carried 69 per cent of tin, and was shipped to Hamburg, Germany, for sale.

Buck Creek is in Seward Peninsula, about 20 miles east of Cape Prince of Wales. It is a short creek, only about 2 miles in length, and has a comparatively small drainage basin. The snowfall of the winter of 1907–8 is said to have been light and the following summer dry, so that water for sluicing was not plentiful.

The tin-bearing gravels are comparatively shallow, from 3 to 10 feet deep, and the tin content is relatively high, 28 pounds or more per cubic yard. The stream tin is derived from cassiterite occurring in small quartz stringers and larger veins in the slate country rock, and, in much less quantity, from tin-bearing quartz porphyries in the hills at the head of the creek. The principal accompanying heavy minerals are pyrite and arsenopyrite, which oxidize, leaving only iron oxides in the gravels, so that the stream tin is of excellent quality.

The Bartels Tin Mining Company, which began prospecting in 1903, continued work on Cape Mountain, near Tin City, 5 miles southeast of Cape Prince of Wales. The company has a number of shafts and tunnels. The tin occurs in its mine as impregnation veins in granite.

The United States-Alaska Tin Mining Company continued driving a prospect tunnel, which was begun in the winter of 1905–6, to cut a vein found higher up on Cape Mountain, on which a 35-foot shaft had been sunk. The tunnel was 421 feet in at the close of the year. No geologist of the United States Geological Survey has been able to examine the ore in the United States-Alaska Tin Mining Company's shaft, owing to water in the shaft. Near the shaft cassiterite is found in large quartz blocks. At other places on the mountain stringers of cassiterite nearly an inch thick have been found in the limestone débris.

Crim, Randt & O'Brien, just before the close of the season, washed a small quantity of stream tin from the gravels along Cas-

siterite Creek, a branch of Lost River, about 30 miles southeast of Cape Prince of Wales. They did some further prospecting upon their tin deposits, but no lode tin was produced. In the course of their prospecting a wolframite deposit was found, which is reported as carrying 30 per cent of wolframite through 3½ feet. The tin deposits in this locality occur in greatly altered quartz porphyry dikes cutting limestone and showing much replacement by fluorite. The cassiterite is evidently later than the dikes. The dikes carry also wolframite and small quantities of scheelite, molybdenite, topaz, axinite, fluorite, and other minerals. On the same claims cassiterite occurs also in quartz veins cutting the limestone. A mile farther up the creek it occurs in a dike composed largely of danburite and brown tourmaline.

Prospectors did some work on Brooks Mountain close to the head of Lost River during the summer, but no finds of tin have been reported. Adolph Knopf, of the Survey, discovered on Brooks Mountain two new tin-boron minerals in 1907, to which he gave the names of paigeite and hulseite. They are not at present of economic importance. Paigeite was also found on Ears Mountain.

North Carolina and South Carolina.—No work is known to have been done in the Carolina field during 1908. The tin-bearing area lies on both sides of the North Carolina-South Carolina line, in Cherokee County, S. C., and in Gaston and Lincoln counties, N. C. Cassiterite occurs as an original constituent of pegmatite dikes cutting gneisses and schists.

South Dakota.—At Tinton, in the northern Black Hills, the Tinton Company remodeled its mill and expects to mine tin ore during 1909.

At Hill City, in the southern Black Hills, the Gertie Tin Mining and Milling Company was also engaged in remodeling its mill during 1908, with the hope of doing active mining in 1909.

The Black Metal Mining Company holds tungsten (wolframite) claims near Hill City that carry a considerable percentage of light colored cassiterite in quartz veins. These veins are in places more than a foot in width, and here and there contain handsome intergrowths of cassiterite, wolframite, and quartz. A considerable amount of development work was done on these claims during the year. No other operations on tin claims of the region, except annual assessment work, are known to have been carried on.

In the Black Hills cassiterite occurs as an original constituent of pegmatite dikes in shoots, about the regularity of which there is doubt. Cassiterite occurs also in quartz veins, which are probably a late if not a final phase of granitic emanation. Many other minerals accompany the cassiterite at various places in the Black Hills, but topaz and axinite are unknown and fluorspar is rarely found.

Washington.—Neither development work nor production during 1908 has been reported from the tin deposits 12 miles south of Spokane, Wash. At this place also cassiterite occurs in pegmatite and is considered by A. J. Collier, who investigated the occurrence for the United States Geological Survey, to be probably an original mineral. It is accompanied by scheelite and wolframite.

Texas.—The Florella Mining Company, which has tin deposits in the Franklin Mountains 15 miles north of El Paso, did some development work during the year, but marketed no ore. Seven veins have

been found upon its property, and the company reported a considerable amount of ore on the dumps. Placer tin has been found in the gulches near the veins. The deposits are replacement veins in granite and carry some wolframite with the cassiterite.

P. H. Parker, Streeter, Mason County, Tex., reported the discovery in 1908 of cassiterite near that place, both as stream tin and in place, the latter apparently in granite. Streeter is in the western part of the "Llano region," an area of crystalline rocks forming an island in the younger sedimentary formations of central Texas. White topaz and quartz penetrated by rutile crystals accompany the cassiterite. The occurrence is apparently more of geologic than of commercial interest.

TESTS FOR TIN ORE.

The simplest and easiest test for cassiterite is to place the mineral in dilute hydrochloric or sulphuric acid with granulated, sheet, or shot zinc. The zinc and the acid cause a rapid evolution of hydrogen, which takes the oxygen from the tin and leaves a coating of the metal upon the fragment tested. Hydrochloric acid and granulated zinc are best to use, as the evolution of hydrogen is very rapid and the zinc particles being small can be made to touch the specimen at many points and thus bring more of the hydrogen in contact with the tin-oxide molecules. The reaction is $4H + SnO_2 = Sn + 2H_2O$.

The metallic coating has a dull gray, somewhat leady appearance as formed, but it may be made lustrous by rubbing with a soft cloth or the hand. In the latter case the familiar disagreeable odor given when tin is rubbed on the flesh is obtained.

This excellent method may be used upon specimens which it is desired not to injure, such as crystals or other choice pieces. However, the smooth surfaces of stream-polished wood-tin are roughened, owing to the impurities contained in the mineral, though the surfaces of ordinary crystalline cassiterite are not noticeably affected. After the test is made the metallic tin coating can be removed by immersing the piece in dilute hydrochloric, sulphuric, or nitric acid.

A better-known and often-used test, though one not so readily made, is the blowpipe test. The mineral supposed to be cassiterite is pulverized, and when so treated should yield a light-colored powder, unless mixed with iron oxides, in which case the powder will be reddish or brownish. A small portion of the powder is mixed with twice its bulk of pulverized charcoal and three times its bulk of sodium bicarbonate (ordinary baking or washing soda). The three substances are thoroughly mixed, and a portion the size of a pea is moistened and placed in a hollow in a piece of charcoal. On application of a reducing blowpipe flame tin is readily reduced in small globules, which are easily distinguished from the flux. After cooling the metallic globules may be separated from the soda and will be malleable. If large enough they will give the disagreeable tin odor when rubbed between the fingers, and will give a white precipitate when treated with concentrated nitric acid. They are soluble in hydrochloric acid, and no precipitate forms when the solution is cold. These reactions with acids differentiate the metal from lead.

PRODUCTION OF TIN IN FOREIGN COUNTRIES.

At the time of writing (June, 1909) it is not possible to obtain the figures of production for 1908 of all the tin-producing countries, but as shown by exports the following table, compiled by C. Mayer, secretary of the New York Metal Exchange, gives the approximate output for the year:

Supply of tin in 1907 and 1908, in short tons.

	1907.	1908.
Total shipments:		
Straits Settlements	58,800	67,760
Australia	7,112	6,552
Bolivia	17,136	19,040
South Africa	.....	1,904
China	224	.....
Banka sales in Holland	12,197	12,880
Billiton sales in Java	2,408	2,464
Production in Cornwall	5,488	6,048
Total	103,365	116,648

From this table it is evident that, in spite of what are in many places considered low prices, there was a large increase in the total production of tin, and that the supply for 1908 was the largest year's supply in the history of tin mining. Australia and China are the only countries that showed a decrease. In the latter case a decrease of exports is not surprising, as it is ordinarily only in years of high prices that tin is drawn into the world's trade from Chinese sources. Little is known of the Chinese tin deposits.

The available figures showing the output of tin for 1908 are as follows:

Production of tin and tin ore in various countries in 1908, in short tons.

	Quantity.	Value.
South Africa,[a] exports	[b] 2,361	$555,467
Federated Malay States,[c] exports	[c] 56,935	.....
Tasmania,[d] ore	5,063	2,051,619
Australia:		
New South Wales[e] ore	942	385,208
New South Wales[e] tin ingots	1,068	614,600
Victoria,[f] ore	89	29,540
Western Australia,[g] ore and ingots	1,224	405,355
Northern territory,[h] exports, ore	501	175,145
Queensland,[i] ore	5,404	1,665,273
Italy [j] (Province of Pisa), ore	272	3,814
Singkep,[k] pig tin	499	262,995
Bolivia,[l] ore	32,932	[n] 10,756,800
Burma,[m] ore	106	53,604

[a] Third annual statement of the trade and shipping of the colonies and territories forming the South African Customs Union, Cape Town, 1909.

[b] Letter from P. M. O'Connor, for Director of Geological Survey of Transvaal, April 19, 1909. Of this total the Transvaal produced 1,426 tons, valued at $487,706.

[c] Statement of F. J. B. Dykes, Senior Warden of Mines, Federated Malay States, quoted in Min. Jour., London, vol. 85, 1909, p. 324. This tonnage paid a duty of $5,334,010.

[d] The progress of the mineral industry of Tasmania for the quarters ending June 30 and December 31, 1908. Hobart, 1908 and 1909.

[e] Letter from E. F. Pittman, Under Secretary for Mines, New South Wales, dated May 3, 1909. Tin ingots from imported ores were also produced to the amount of 1,153 tons, valued at $664,136.

[f] Letter from I. Cohen, for Secretary of Mines, dated April 28, 1909.

[g] Letter from A. Gibb Maitland, Government Geologist, dated April 19, 1909.

[h] Min. Jour., London, vol. 84, 1909, p. 233.

[i] Queensland Government Mining Journal, vol. 10, 1909, p. 175.

[j] Letter from P. Zezi, l'inspittore superiore capo del corpo reale delle miniere, Rome, May 15, 1909.

[k] Report of the Singkep Tin Company for year ending June 30, 1908, translated and quoted in Min. Jour., London, vol. 84, 1908, p. 686.

[l] Winslow, Alfred A., Daily Cons. and Trade Repts., Washington, June 11, 1909, p 2.

[m] Advance statement of mineral production of India by the Director of the Geological Survey of India, June 10, 1909.

[n] Value from Bull. Internat. Union Am. Republics, July, 1909, p. 37.

IMPORTS.

During the year 1908 the United States imported for consumption 41,267 short tons of pig tin, valued as entered at $23,923,560, an average of 28.986 cents per pound. During 1908, as given by C. Mayer in the Annual Statistical Report of the New York Metal Exchange, the year's average price was 29.42. According to the American Metal Market and Daily Iron and Steel Report,[a] it was 29.54 cents per pound. The agreement between these figures is as close as can be expected on an article which has a fluctuating price, and when it is also considered that the average price for the importation is exact as far as the invoice figures may be depended upon, while the market figures are an approximation.

The imports of tin into the United States since 1901 have been as follows:

Tin imported and entered for consumption in the United States, 1901–1908, in short tons.

Year.	Quantity.	Value.
1901	37,280	$19,024,761
1902	42,522	21,263,337
1903	41,567	22,265,336
1904	41,472	22,356,895
1905	44,188	26,316,023
1906	50,477	37,447,315
1907	41,257	32,074,263
1908	41,267	23,923,560

The imports of 1907 and 1908 were remarkably close in quantity, only 10 tons more being imported in 1908 than in 1907; the difference in value, however, was very striking, being $8,150,703, or about 25 per cent, less in 1908 than in 1907 for almost precisely the same quantity.

PRICES DURING 1908.

In 1907 prices reached 44⅜ cents per pound in May, and fluctuated considerably, especially during the first half of the year, but later they dropped and became somewhat steadier toward the end of the year, which closed with tin at 27¼ cents per pound.

In 1908, as shown by the Annual Statistical Report of the New York Metal Exchange, tin opened at 26.625 cents per pound, averaging 27.35 cents during January. The highest price during the year, 32.275 cents, was toward the end of April, and the lowest, 26.25 cents, was in the beginning of January. Metal Statistics, p. 69, gives the lowest price as 26.45 and the highest as 32.75, with an average for the year of 29.54 cents per pound. As a whole, the tin markets for the year were steady, compared with those of recent years.

RECOVERED TIN.

The recovery of tin from scrap, dross, type metal, babbit and other friction metals, bronze, etc., is growing, and especially is attention being given to saving tin from scrap, old cans, and similar waste.

The tin in tin plate, when exposed to the weather, slowly oxidizes, and the oxide, a brittle, hard, colorless substance, falls off as an imperceptible dust and is dissipated. When this happens the tin is lost for all time, so far as further use is concerned. The color of rusting tin

[a] Metal Statistics, 1909, p. 72.

plate is due wholly to oxides formed from the iron on which the tin is coated. The problem of recovering tin from old cans and other used tin plate is not simple. In structure tin plate is made up of a sheet of iron or steel, both sides of which are thinly coated with tin. The outer surfaces are practically pure tin, but between them and the iron is a film of an alloy of iron and tin, which forms the cement that holds the metals together. The whole of the tin amounts to only 1.5 to 3 per cent of the mass. In a process which depends on melting the tin from the tin plate only the outer film of tin, already partly oxidized, can be recovered. The alloy films will not yield to such a simple process. Chemical or electrolytic processes are necessary to separate the alloy. These are not extremely troublesome for clean material, such as new scrap. By far the greatest loss of tin, however, is not through scrap, but in tin plate that has been used, such as cans of various kinds—matter that is necessarily dirty. It can not be put into electrolyte direct without spoiling the electrolyte, and in chemical processes the chemicals are destroyed and lost in the dirt. Owing to these complicated conditions many processes have been devised and patented for treating tin-plate wastes, but so far as known the only commercial operations on such waste in this country are confined to the treatment of clean tin scrap. Some tin is also recovered by remelting block-tin pipe and other articles made of tin.

During 1908, as reported by 33 companies, the quantity of tin recovered as such was 1,124 tons; of tin contained in alloys, including babbit, type metal, bronze, etc., it was 1,666 tons, a total of 2,790 tons, valued at $1,641,476. For 1907 sixteen companies reported a saving of 93 tons of tin as such and of 1,569 tons contained in alloys, the total being valued at $914,404, but a fair comparison of the two years can not be made owing to incompleteness of the data for 1907.

A large but unknown recovery of tin from secondary sources was also made in Europe in 1908.

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During 1908 the following papers dealing with various phases of tin deposits were published:

ANONYMOUS. Tin mining in the island of Billiton. A general sketch: G. Kolff & Co., Batavia, Java, 1908, pp. 31.

Treats of the political, topographic, geological, and commercial aspects of Billiton, Dutch East Indies, and its tin-mining industry. Treats in excellent manner the methods of working the deposits (from the commercial side rather than the mechanical) and of handling the Chinese laborers. Besides tin, iron is the only commercial mineral found in quantity. There are small amounts of tungsten, gold, lead, and copper.

Probably the most intimate and best account of Billiton tin-mining conditions printed in English.

——— The mines of Montebras: Min. Jour., London, vol. 84, 1908, p. 3.

A very general description of the developments, dressing plants, and tin deposits at Montebras in central France. Antimony, amblygonite, and montebrasite occur with tin ore, which is said to average 2 per cent cassiterite.

——— Tin in Argentina: Echo des Mines, Paris, 1907.

Translation in Min. Jour., London, vol. 83, 1908, p. 6, states that cassiterite is found near Tinogasta, Catamarca, and that mining has begun at Mazan, La Rioja. The tin is in stockwerks in granulite. Ore averages 1.8 per cent (tin?), 1.28 meters thick, and is accompanied by a little wolframite. One hundred miners are said to be employed.

——— The tin deposits of Cape Peninsula: South African Min. Rev., December, 1908, 2 pp.

Not available to writer.

ANONYMOUS. Potgietersrust tin fields: South African Min. Jour., May 23, 1908, 1½ pp. Not available to writer.

——— Cornish tin mining: Eng. and Min. Jour., vol. 86, 1908, p. 181.
A discussion of the costs of tin mining in Cornwall, and reasons for loss at some mines.

BALDAUF, MARTIN. Bergmannische Reisebriefe aus England. Die zinnerzgruben in Cornwall bei Redruth und Camborne: Oesterreich. Zeitschr. Berg. und Huttenw., vol. 56, 1908, pp. 17–21.
Describes Basset, Dalcoath, and East Pool mines, particularly the dressing plants.

BALFOUR, JOHN FORDYCE. Appendix I to "British Malaya with more especial reference to the Federated Malay States," by Wm. Hood Treacher. Jour. Soc. Arts, vol. 55, pp. 505–507.
Treats of the general features of the Malay Peninsula, its geology, and the tin deposits. Covers briefly lode mining, impregnation deposits, and alluvial deposits.

COLLIER, ARTHUR J. Tin ore at Spokane, Wash.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 295–305.
Cassiterite occurs in an elevation known as Silver Hill near Spokane. Cassiterite is in pegmatite accompanied by sillimanite, andalusite, and tourmaline. Wolframite and scheelite occur in granite in the same hill.

CONDOR, HARTWELL. The occurrence of stannite in Australasia: Australian Min. Standard, vol. 40, 1908, p. 577.
Gives a description of stannite and mentions localities in which it has been found; states that it occurs in considerable quantity in the Conrad mines, New South Wales, and in the Oonah mine (Zeehan) and at Heemskirk, Tasmania. In the Conrad mine stannite occurs in a quartz vein cutting granite, and is accompanied by argentiferous galena, zinc blende, chalcopyrite, and aresnical pyrites. Cassiterite occurs in the granite, but rarely if ever in the vein. At Oonah stannite occurs with bismuthinite, wolframite, galena, pyrite, and zinc blende in a vein between quartzite and graphitic schist and closely connected with galena deposits. The stannite at both places is argentiferous. Discusses difficulties of treatment.

"CORNUBIAN." Lode mining in the Malay States: Min. Jour., London, vol. 84, 1908, p. 622.
Letter in which a correspondent states that the lode mines of Pahang are among the big tin mines of the world, and gives figures to support his statement.

DUNSTAN, B. Stanhills tin fields. Queensland Govt. Min. Jour., vol. 9, 1908, pp. 285–288; 1 map and 3 plates. Also issued as Queensland Geol. Survey Pub. No. 211.
Discusses geology, mines, alluvial deposits, and prospects of the Stanhills district, Queensland. Cassiterite occurs in altered granite or in close connection with granite with much chlorite. Galena, zinc blende, chalcopyrite, and graphite occur with the tin. Alluvial deposits occur in the neighborhood, around the head of Tenmile Creek.

EDLINGER, W. Einige Bemerkungen über die Zinnerzlagerstätten des Herberton districts in Queensland. Zeitschr. prakt. Geologie, Berlin, vol. 16, 1908, pp. 275–279 and 340–343. I. Die primären Lagerstätten, pp. 275–279. A description of the lode occurrences. II. Die Zinnseifen, pp. 340–343. Description of eluvial, alluvial, and fossil ("deep leads") placers.

FARRELL, JOHN R. Tin and copper deposits of Katanga: Eng. and Min. Jour., vol. 85, April 11, 1908, pp. 747–753.
Treats the tin of the country in several paragraphs. Pieces of stream tin weigh as much as 156 pounds. Quartz and tourmaline in the gravels; quartz veins carrying cassiterite are supposed to be the origin of the stream tin. Eight and one-half tons of tin were smelted.

GOOD, T. The world's tin supply: Cassier's Magazine, vol. 34, 1908, pp. 483–487.
Wrong and insufficient data lead to the conclusion that there is no danger of the world's tin supply giving out in the near future.

GRIFFITHS, HARRY D. Tin mining in Cape Colony: Paper read before the Chem. and Metallur. Soc. of South Africa; abstract in Min. Jour., London, vol. 83, 1908, pp. 119–120.
Cassiterite occurs with quartz veins in coarsely crystalline granite. Highly micaceous greisen lies along the veins, and the granite shows gneissoid structure near them. Cassiterite in the quartz veins is brownish or black, in large masses or in stringers along the foot wall and joints. Fine grains of brown cassiterite occur in the greisen. Wolframite occurs in the quartz where cassiterite is lacking. Stream tin, formed from the veins, occurs in quartz fragments in a bed 4 to 10 feet thick overlain by as much as 30 feet of detritus. Describes methods of working and washing.

JOHNSON, J. P. The tin, molybdenum, and lead occurrences near Potgietersrust: Trans. Geol. Soc. South Africa, Johannesburg, vol. 10, 1908, pp. 115–119. Reprint Min. Jour., London, vol. 83, p. 473.

Between the Magalakwin and Sterk rivers in Groenfontein, Roodepoort, and Sterkwater, South Africa, coarsely crystalline cassiterite occurs in a quartz vein carrying fluorite and a green micaceous mineral; finer-grained cassiterite occurs in the granite on each side for a width of 120 feet. East of this cassiterite occurs as an impregnation in cylindrical pipes in granite with molybdenite, pyrite, chalcopyrite, arsenopyrite, and galena. Some cassiterite occurs in molybdenite deposits which carry much tourmaline and a little sphalerite.

KNOPF, ADOLPH. Geology of the Seward Peninsula tin deposits, Alaska: Bull. U. S. Geol. Survey No. 358, 1908, pp. 71, 9 plates (including map of western end of Seward Peninsula), and 7 figures.

Describes the geology and mineralogy of the tin deposits of Seward Peninsula; mining operations and development; and two new tin-boron minerals, hulseite and paigeite.

KYNASTON, H. Report on a preliminary examination of the cassiterite deposits of Zaaiplaats, and some of the neighboring farms of the Waterberg district: Transvaal Mines Dept., Rept. Geol. Survey for 1907, Pretoria, 1908, pp. 91–102, figs. 5–7. Reprinted in South African Min. Jour., November 21, 1908.

The cassiterite occurs in the red (Bushveld) granite in pipes and shoots. The former are cylindrical bodies of altered granite impregnated with ore and sometimes surrounded with a selvage of tourmaline, fluorspar, copper and arsenical pyrites, specularite, blende, galena, stibnite, wolframite, and molybdenite.

LEWIS, JAMES B. Tin mining in Tasmania: Eng. and Min. Jour., vol. 85, 1908, pp. 485–489; 3 plates and 1 map.

Commercial conditions at the Mount Bischoff, Heemskirk, Brookstead, Avoca, Briseis, and Pioneer mines are described. Gives a few notes upon dredging for tin in Tasmania, and refers to tin-mining operations in the Gladstone district.

MACALISTER, DONALD A. Geological aspect of the lodes of Cornwall: Econ. Geology, vol. 3, 1908, pp 363–380; 1 geological map.

Treats history of mining in Cornwall; total yield of tin and copper; general geology; lodes; relations of the ores of tin and copper to the granite; nature of the vein fillings; pneumatolytic alteration and metasomatism; genesis of the ores; silver-lead veins; iron deposits; alluvial deposits of tin.

MERENSKY, HANS. The rocks belonging to the area of the Bushveld granite complex, in which tin may be expected, with descriptions of the deposits actually found (read March 16, 1908): Trans. Geol. Soc. South Africa, vol. 11, 1908, pp. 25–42.

Discusses the general theory of tin deposition, the rocks surrounding the South African deposits, and their relative ages. Takes up the tin deposits and discusses them and their accessory minerals, and also other veins which seem to to bear a close relation to the tin veins. Treats the Rooiberg, Warmbad, Nylstroom, and Potgietersrust districts. Holds theory that tin ore was deposited largely from thermal solutions.

MONTIS, E. DE. Mining in Honduras: Mexican Min. Jour., vol. 7, 1908, p. 24.

Makes bare statement that, among other metals, tin is found in Honduras.

PEMBERTHY, JOHN. Tin mining in Bolivia: Am. Min. Rev., vol. 24, November 7, 1908, p. 1, 1 pl. Abstract of paper read before Royal Cornwall Polytech. Soc.

Briefly describes the tin mines and mining conditions existing in Bolivia.

PILZ, R. Die Erzlagerstätten von Cartagena in Spanien: Zeitschr. prakt. Geologie, vol. 16, 1908, pp. 177–190, figs. 31–37.

A study of the geology, the occurrence, and the mining of lead, zinc, copper, iron, and tin in Cartagena.

PREUMONT, G. The Bolivian tin mining industry and railways: Min. Jour., London, vol. 83, 1908, pp. 5, 6, 65, 66.

Bolivian tin deposits are discussed with regard to the effect that the building of several proposed railroads will have on their exploitation.

———. Northern tin fields of Bolivia: Min. Jour., London, vol. 83, 1908, pp. 160, 249, 314.

Describes the topography and natural characteristics of the northern tin fields of Bolivia; commercial and labor conditions. Tells little of the geology. Gives details of individual mines.

Recknagel, R. On some mineral deposits in the Rooiberg district: Trans. Geol. Soc. South Africa, Johannesburg, 1909, pp. 83–106, pls. 6–16. Read July 20, 1908.

Describes the geology of the country in the neighborhood of Rooiberg, 40 miles west of Warmbaths. Tin occurs in granite, in irregular pockets, as veins in sediments, and as replacement deposits in quartzite. In one group of replacement deposits cassiterite occurs with cobaltite, scheelite, cupro-scheelite, wolframite, and tourmaline. Nickel deposits are possibly connected with the tin deposits. The tin deposits were worked long ago, as shown by old pits, slag dumps, etc., but by whom is unknown.

Romaña, E. A. L. de. Una inspección de los yacimientos de estaño de Bolivia y una exploración por el mismo metal en el Perú: Bol. Cuerpo de Ingenieros de minas del Perú, No. 57, 1908, 99 pp., 26 pls., 2 maps. Abstract Min. Jour., London, vol. 84, 1908, pp. 37–38; 91–92.

Description of the distribution, geology, and mineralogy of the Bolivian tin deposits and methods of working them; also a review of the known tin deposits in Peru.

Rumbold, W. R. The South African tin deposits: Bull. 22, Am. Inst. Min. Eng., 1908, pp. 601–607, 5 figs.

Describes the Cape Town (Kuils River), Bushveld, and Swaziland (Oshoek and Forbes Reef) tin deposits as they appeared in 1904. At Kuils River crystallized pinkish-gray cassiterite occurs with wolframite in a 5-foot quartz vein cutting granite. Placers have been formed from the vein. At Bushveld cassiterite occurs with quartz in decomposed granite. The Oshoek deposits are stanniferous hornblende pegmatites, and placers derived from them; carry garnet, monazite, euxenite, and æschynite, with large isolated crystals of cassiterite. In the Forbes Reef deposits cassiterite occurs in an aplite dike and in thin veins cutting schists which carry cinnabar, gold, scheelite, bismuth, monazite, euxenite, æschynite, copper and iron pyrites, pyrrhotite, margarite, and tourmaline. Crystals from the vein, when scratched, sometimes fly to pieces like Rupert's drops. The description shows a marked resemblance between some of the South African deposits and some of those near Hill City, S. Dak.

Swinburne, —. Government tin prospecting in Transvaal: Transvaal Govt. Gazette, November 29, 1908: Reprinted in part in Min. Jour., London, vol. 83, 1908, p. 7.

States that cassiterite occurs in fine grains in chimneys in red granite; in large crystals in pegmatite: and in alluvial deposits derived from the others. Their extent is unknown.

Voit, F. W. Uebersicht über die nutzbaren Lagerstätten Südafrikas: Zeitschr. prakt. Geologie, vol. 16, 1908, pp. 191–216.

A geologic study of the economically valuable mineral deposits of South Africa, including gold, diamonds, copper, graphite, tin, monazite, iron ores, magnesite, asbestos, etc.

Woodward, Harry P. Greenbushes tin field (with special reference to the deep leads): Bull. 32, Western Australia Geol. Survey, Perth, 1908, pp. 1–75, 3 maps and 3 plates.

A general description of the district and its mineralogy, with detailed descriptions of claims.

PLATINUM.

By David T. Day.

PRODUCTION.

The conditions of platinum production in the United States, where the metal is obtained as a by-product in placer gold mining, have not changed significantly in the last twelve months, although in one or two large mines in California apparatus modeled after that used in the investigations of black sands at the Portland Exposition in 1905 has been installed for greater economy in saving the platinum. The production in 1908 increased over that of 1907 from 357 ounces to 750 ounces. The total value was not proportionately as great, inasmuch as the price for ingot platinum declined from $25, at the close of 1907, to $18.20 in August, 1908, when a rise began, bringing the price to $24.50 in November, with a slight decline at the end of the year. The decline in price during the year may be attributed chiefly to stagnation in the manufacture of sulphuric acid and in other industries in which platinum is used.

Production of crude platinum in the United States, 1880–1900, and of refined platinum from domestic ores in 1901–1908, in troy ounces.

Year.	Quantity.	Value.[a]	Year.	Quantity.	Value.[a]
1880	100	$400	1895	150	$900
1881	100	400	1896	163	944
1882	200	600	1897	150	900
1883	200	600	1898	225	3,375
1884	150	450	1899	300	1,800
1885	250	187	1900	400	2,500
1886	50	100	1901	1,408	27,526
1887	448	1,838	1902	94	1,874
1888	500	2,000	1903	110	2,080
1889	500	2,000	1904	200	4,160
1890	600	2,500	1905	318	5,320
1891	100	500	1906	1,439	45,189
1892	80	550	1907	357	10,589
1893	75	517	1908	750	14,250
1894	100	600			

[a] The chief variations in price up to 1901 have been due to the quality of the crude product. Since 1901 the average price for the refined metal has been given.

IMPORTS.

The imports of platinum from other countries, chiefly Russia, declined in 1907 and in 1908 both as to quantity and value, as shown in the table given below:

Platinum metals imported and entered for consumption in the United States, 1902–1908.

Year.	Platinum ore or crude platinum, including unmanufactured products, ingots, bars, sheets, and wire.		Manufactured products, including vases, retorts, etc.	Total.
	Quantity.	Value.	Value.	Value.
	Pounds.			
1902	7,345	$1,950,362	$37,618	$1,987,980
1903	7,734	1,920,044	135,889	2,055,933
1904				1,879,155
1905	7,826	1,985,107	188,156	2,173,263
1906	11,494	3,601,120	187,639	3,788,759
1907	6,191	2,508,991	175,651	2,684,642
1908	4,237	1,095,754	134,119	1,229,873

PRICES.

The following table gives the prices of ingot platinum per troy ounce at New York, by months, for the calendar years 1906, 1907, and 1908:

Prices of ingot platinum per troy ounce on the New York market in 1906, 1907, and 1908, by months.

1906.

January	$20.50	July	$26.00
February	25.00	August	26.00
March	25.00	September	33.00
April	25.00	October	33.00
May	25.00	November	38.00
June	26.00	December	38.00

1907.

January 1	$38.00	July 25	$27.00
February 20	37.00	August 1	27.50
March 20	36.00	August 15	28.00
April 1	34.00	September 20	27.00
April 10	32.00	October 20	26.50
May 10	31.00	December 1	26.00
May 20	28.00	December 15	25.50
May 25	26.00	December 31	25.00

1908.

January	$22.30	July	$19.60
February	22.10	August	18.20
March	21.80	September	18.60
April	21.75	October	21.15
May	21.35	November	24.50
June	19.85	December	24.10

NOTES ON THE PLATINUM INDUSTRY.

UNITED STATES.

All of the platinum produced in the United States is recovered from placer mines in Oregon and California, which also produce gold. The bulk of the production of California comes from the dredges at Oroville, in Butte County, but small quantities are also recovered from Humboldt, Siskiyou, Trinity, Del Norte, Sacramento, and Calaveras counties. In Oregon small quantities are obtained from Coos, Curry, and Josephine counties. The platinum is usually panned from the black sand, but a small quantity is entangled with the amalgamated gold and is finally recovered in the refining operations at the mints. In 1908, 1,214 ounces of platinum were recovered at the mints, but only a small portion of this is derived from the placer gold, the bulk being obtained from scraps of various kinds, principally from dental work, which are sold to the mint.

The total production credited to California is 706 fine ounces, valued at $13,414; Oregon is credited with 44 fine ounces, valued at $836.

There was no production from the copper ores of Wyoming, which in places contain platinum. A new district in which platinum is reported to occur in primary ores, associated with copper and nickel, was discovered some years ago in southern Nevada. Howland Bancroft, of the United States Geological Survey, visited this region in 1909 and has furnished the following résumé of its geologic features:

PLATINUM IN SOUTHEASTERN NEVADA.

The district is located in Clark County, Nev., 16 miles from Bunkerville, at an elevation of 4,175 feet above sea level, about 45 miles by wagon road east of Moapa station on the Salt Lake route.

The country traversed on the way to the prospects is principally desert waste. About 4 miles west from the Key West property a capping of Paleozoic (?) limestone becomes quite prominent. This overlies the older gneiss and is separated from it by a limestone conglomerate which seems to occupy the uneven surface of the gneiss. The limestone is continuous up to within 2 miles of the properties examined, where it has been entirely eroded. Two miles west of the prospects the limestone can again be seen. The Key West mine has shipped one carload of ore. No shipment has been made from the Great Eastern.

On the Key West there is in all a little over 3,000 feet of development work. This includes 2 shafts, the main one being down 312 feet, 3 levels, winzes, and drifts. As the lower levels were under water, information upon the workings below the 120-foot level was given by S. W. Darling, superintendent of the Key West.

The Great Eastern has been developed by crosscuts only on 2 levels. In all there is some 600 feet of work done on the prospect.

The geology in the immediate vicinity of the prospects consists of coarse-grained gneisses, apparently of granitic origin, showing distinct gneissic structure. The prevalent direction of schistosity seems to be northeast with a very steep dip to the northwest. These rocks stand almost vertically and, with the accompanying jointing parallel to the shearing planes, form in places prominent ridges. Along these ridges can be seen distinctly the successive intrusions of various basic rocks with aplite and pegmatite, all of which are common to the region. The two latter intrusives are evidently later than the metamorphism of the region. The ore body is simply a very basic intrusive in the gneisses and differs mainly from the numerous dark-colored dikes found throughout the area in its large content of augite and olivine. The rock in which the values occur is a peridotite. The writer was informed that values are also obtained from a rock which appears to be a typical hornblendite or a very hornblendic phase of diorite. Assays will be made of the various rocks, and the results will be published later. In places the dikes evince the results of intense movement

and lead one to believe that the metallic elements of the rock have simply concentrated during metamorphism. The only metallic minerals visible in the unaltered dikes are the various sulphides of iron and copper.

The ore bodies proper occur in peridotite dikes which are exposed in several different places on the way from the Great Eastern property to the Key West, a distance of about 1 mile. The extent of outcrop upon the surface was generally 100 feet or more and varied in width from 10 to 50 feet. It is probable that these will be faulted in various places both laterally and vertically, as indicated by the fault in the Key West property and by the displacements seen in the country rock in the vicinity. The Key West and the Great Eastern are both located on similar dikes.

Both properties appear to be more valuable for their nickel or copper content than they are for their platinum. A series of assays of Key West ore made by H. E. Wood, of Denver, in 1900 shows an average of 3.9 per cent copper, 2.92 per cent nickel, 0.05 ounce gold, and a trace of silver for the sulphide ores. Whether Mr. Wood tested for platinum or not is uncertain. At any rate his returns do not indicate the presence of platinum. Mr. Trent, of Pioche, Nev., who examined the property in 1903, had some assays made at Stanford University which ran, according to his report, 1.7 per cent copper, 1.3 per cent nickel, and 0.05 ounce platinum.

Assays from the Great Eastern are stated to show 1.5 per cent copper, 0.9 per cent nickel, 0.25 ounce platinum.

If these properties were near a railroad, or if the ore could be treated on the ground, it is quite probable that they would be able to produce bullion. Under present conditions, however, working expenses would be very high. The Key West property has not been worked for six years.

RUSSIA.

The most reliable figures obtainable for the production of platinum in Russia are given in the following table:

Production of platinum in the Ural Mountains in the last few years, in troy ounces.

1894	203,250	1904	190,120
1896	200,000	1905	200,450
1898	203,100	1906	210,318
1900	212,500	1907	142,570
1903	226,000	1908	[a] 138,000

A valuable report has recently been published by Dr. W. Geibel[b] on the conditions of mining in Russia, including a criticism of the statistics of production and a statement of the general conditions under which platinum is sold. An extended abstract from this report is given below:

DEPOSITS.

The oldest deposit of platinum is situated in the district of Nischne Tagilsk, below 58° north latitude, about 100 kilometers north of Yekaterinburg, the chief mining city of the Urals. The center of this district is Solowieffberg, the only place where platinum was found in place. The alluvial deposits of four streams, which have their source on its slopes, contain platinum; the total length of the platinum-bearing river beds amounts to 106 kilometers. Three of the streams flow toward the European slope, one to the Asiatic.

Tagilsk was for a long time the principal place of production, and up to the year 1891 produced 77 per cent of the total output of platinum. Since 1825 about 100 tons of platinum have been gotten out there. The beds are now pretty well exhausted and are surpassed in production by the northern districts; in late years they have not yielded more than one-fourth of the total production. The old tailings are now largely reworked. The platinum beds of the district are for the most part owned by Prince Demidoff.

About 120 kilometers north of Nischne Tagilsk, on the Asiatic slope of the mountain range, lie, near together, the districts of Bissersk and Goroblagodat. Two rather large rivers, the Iss and the Wija, with numerous tributaries, contain platinum; at

[a] Estimated.
[b] "Platin:" Private report by Dr. W. Geibel, Hanau, Germany.

their source lie three rock masses consisting of peridotite. The Iss and the Wija empty into the Tura, which for a little distance from the mouth of these tributaries also contains platinum. The total length of the alluvial beds worth washing is 130 kilometers. At present these two districts are the principal producers of platinum, their production amounting to about 70 per cent of the total output; but, in the opinion of the experts, with the present intensive exploitation—on the Iss there are at work about 60 washeries, on the Wija 100—their wealth will be exhausted in about ten years. The most important beds in the district of Bissersk belong to Count Schuwaloff; those in the district of Goroblagodat to a French stock company, the Compagnie Industrielle du Platine.

The more northerly beds, situated in the district of Bogoslowsk, below 60° north latitude, are in process of development. The two old regions lie in the vicinity of the Ural railway, but Bogoslowsk is situated nearly 200 kilometers from it and was not opened to trade until 1906 by the building of a branch road. The production of this district so far is small; there is hope, however, that it will increase substantially. The northerly limit of platinum is not marked by this district. Its presence has been proved as far north as 62° north latitude. From there on to the Arctic Ocean stretches an unexplored, uninhabitated region for a distance of 600 kilometers. We know that the chain of eruptive rock stretches to the sea. When the inevitable exhaustion of the old beds takes place, the industry may be transferred to this region. Of course the cost of production will rise markedly.

METHODS OF EXTRACTION.

Platinum is obtained almost exclusively by placer methods. The overburden is taken off, and the platinum-bearing material is raised and carried to the washer on barrows. As running water is the principal requisite, the ore can be dressed only during the few summer months.

The separation of the platinum is more or less perfect, according to the kind of apparatus used. The simplest washing appliance is a hemispherical pan holding about 5 kilograms, in which, with the help of the running water, a small quantity of the material is washed by hand until only the heaviest particles—glittering grains of platinum together with chromite and magnetic iron—remain at the bottom. This pan is used principally for sampling. It is, however, used for the real extraction of the platinum in the unfortunately still very prevalent so-called "starateli" work. For the owner who can not or will not invest capital in machinery, the most convenient method of getting his treasure is to give permission to the little groups of workmen roaming about—the starateli—to work his property at their own expense; he then buys from them the platinum obtained at a stipulated low price. This method causes great wastefulness in mining. The laborers work only the very richest deposits, and these most imperfectly, with their primitive implements. They give up only a part of the platinum obtained, for traveling agents pay a somewhat higher price. The owners know this very well, but they can not prevent it; for any system of supervision would cost money, and so they content themselves with the profit that they can get without trouble.

The commonest apparatus for extraction on a large scale is the washer. It consists of a common wooden sluice as flat as possible and about 8 to 13 meters long, the bottom of which is suppled with numerous diagonal riffles, with a reservoir above and another below them. The platinum-bearing material is shoveled into the upper reservoir, stirred up by a powerful stream of water, and forced into the sluice, where the particles of metal settle in front of the riffles. In the lower settling basin the remaining platinum collects.

The sluice is operated for a period of twelve hours, then a clean-up is made from sluice and basin and concentrated on another smaller washer. The gold is extracted by amalgamation. By the best methods about one gram of the precious metal is recovered from a ton of sand, and we may safely assume that about 10 per cent of the platinum content is lost. At least as much more is stolen. The workmen are extremely skillful in stealing, even under strict surveillance.

The methods described are followed when the platinum deposit is in an old river bed or on the banks of a river. The present beds of these rivers also usually contain platinum, and to obtain this platinum other processes must be used. Up to a short time ago the only one in use was the "freeze out." This method consists in sinking a shaft in the frozen river bed and extracting the material that is worth washing.

Not until 1900 was the present method of extraction introduced—the floating dredge. This requires a larger business capital, but admits of far quicker operation. The dredge, or "draga," is run by steam power and can accomplish with a force of 30 workmen as much as 600 men can accomplish with washers. Its use is not now limited

to the river bed only, but as the river banks are usually marshy for some distance back, the dredge, which makes its own basin, can penetrate far into the bank. The drawbacks to dredge work are, first, the very high cost—a dredge costs about 100,000 rubles (about $52,000)—and, secondly, the impossibility of raising all the platinum-bearing stratum from the river bed. The platinum-bearing material lying in the depressions of the bed rock is mostly lost in this process, though it can be gotten out by hand work.

STATISTICS OF PRICES AND PRODUCTION.

The first purchaser of the ore was the Russian Government. From 1825 on it bought up the total production and used it in coining platinum coins. Up to the year 1845 an average of about 1,500 kilograms was obtained each year. Then the Government stopped the coinage, and because other large buyers were not forthcoming the production fell quickly and in 1855 reached its lowest point with 16 kilograms. In the meantime the industry of western Europe had discovered the value of the metal for chemical uses, and in the year 1857 the London firm of Johnson, Matthey & Co. appeared in the market as buyers and pledged themselves to buy the whole Demidoff output for a series of years. In consequence, production again increased quickly and in 1870 amounted to about 2,000 kilograms. The other beds, which had no buyers, had to lie idle and could not resume production until German and French firms entered the market as competitors of Johnson, Matthey & Co. Work was then again taken up in the district of Goroblagodat in the year 1867.

In spite of the growing production, prices rose slowly but steadily until 1890. The industrial demand became greater and greater, and production could hardly keep pace with it. In the year 1890 the price curve shows a sudden rise from 1,000 marks ($238) to 2,600 marks ($619) per kilogram, but in 1892 it fell again as quickly to 750 marks ($179). These fluctuations of the market were caused by the attempt of the producers, aided by French firms, to form a trust. Production was reduced purely for speculative purposes and prices rose. But now the high prices led on the one side to a considerably increased production outside the trust and on the other to a decrease in consumption. The inevitable result was a large supply of ore, and in a few months a strong depression of prices ensued. The unsuccessful speculation naturally resulted in the ruin of numerous small producers.

About the middle of the nineties the extraordinarily low prices of the metal, combined with a simultaneous rise in wages, led to a combination among a number of the larger mine owners and finally to the formation of the Compagnie Industrielle du Platine in Paris. This company, organized with a capital of 22,000,000 francs ($4,246,000), got into its possession a considerable part of the platinum fields in the district of Goroblagodat and closed at the same time with Count Schuwaloff and other large producers long-term delivery contracts. Thus it controlled the production of the most important district, while the other district, Nischne Tagilsk, was still under the control of Johnson, Matthey & Co. In this way by far the larger part of the output was controlled by a few firms. Under their management, production was made to conform to consumption, so that in the years 1891–1905 platinum mining was made a paying business by slowly but steadily rising prices.

The great development of industry in all industrial countries in the beginning of the new century resulted in a large increase in the consumption of platinum. The demand was steadily rising, when in the autumn of 1905 the revolutionary movement in Russia and the interruption of the postal and railway industries for months made every outlet unavailable. Thereupon a platinum famine set in; prices shot up in a few months from 2,600 marks ($619) to 5,000 marks ($1,190) per kilogram; and it began to look as if Russia, the only producer for the world market worth considering, would no longer be able to meet the demand for platinum.

But hand in hand with rising prices goes the effort of industry to find, if at all possible, a substitute for the metal that will soon become exorbitantly dear. The sulphuric-acid factories, which in 1895 were using annually about 2,000 kilograms for their concentration apparatus, sold their platinum and replaced it largely with gold, which was 40 per cent cheaper. In this way they realized enormous profits and at the same time made themselves independent of the fluctuations in platinum. The incandescent-light factories made lamps without platinum, and the jewelers curtailed as far as possible their consumption, which had recently increased extraordinarily. Thus in a few months the consumption fell off more than 50 per cent; the demand ceased entirely, and in a short time prices fell fully 40 per cent.

In view of the difficulty of judging the conditions of production in the Urals, we can hardly say how the market will develop in the future, for these peculiar conditions in Russia make it impossible to give reliable data as to the amount of production. Up to a few years ago all the platinum obtained had, by law, to be shown to the

authorities in Yekaterinburg, and the Government received a tax of 3 per cent of the crude metal. The official data of the Russian statistical office are based on the quantities of platinum thus exhibited. But the producers take care not to show all the platinum mined, so that for this reason alone the official figures are too low. In addition to this, as has already been said, large quantities are stolen during the working, and these, too, escape the knowledge of the authorities. Hence it comes to pass that the total of the figures of consumption for the principal industrial countries is much higher than the figures given for the Russian output. Exact figures of production, which are found in some treatises, are therefore worthless.

COLOMBIA.

The United States Department of State has collected much information, particularly through the American consular service at Bogota, Colombia, in regard to the occurrence of platinum and the general conditions of the industry in Colombia, which ranks as the second producer of platinum and is a region to which great attention has lately been given. The report is accompanied by valuable maps of the occurrence of platinum in Colombia, which may be consulted in the office of the Division of Mineral Resources of the United States Geological Survey. An abstract of the report itself is given below, as furnished by Consul-General Jay White:

The best authorities place the date of discovery of platinum in Colombia at between 1720 and 1727, but the metal attracted little notice in Europe until 1748, and then only as a curiosity. In 1778 Charles III of Spain ordered that all the platinum found in the process of gold mining should be sent to the royal treasury gratis, but ten years later he offered $2 per pound for it, and according to Vicente Bestrepo 3,820 pounds were forwarded at that period.

The Colombian production is estimated by Capt. Charles Stuart Cochrane to have amounted in the year 1824 to 26,400 ounces, and it is estimated by Bestrepo to have been 17,000 ounces in 1826.

The accompanying statistics for 1905, 1906, and 1907 have been furnished through the courtesy of the director of the bureau of statistics of Bogota.

Exportation of platinum from the Republic of Colombia in 1905, 1906, and 1907, by countries, in troy ounces.

Year.	United States.	Germany.	France.	Great Britain.	Total.
1905	3,605.07	106.10	23,450.76	2,539.91	29,701.84
1906	3,917.96	.....	2,550.33	322.12	6,790.41
1907	245.86	.....	.....	.....	245.86
	7,768.89	106.10	26,001.09	2,862.03	36,738.11

During the nineteen years preceding 1846 the production of Russia did not seriously compete with Colombia, because the Russian product was used for the most part by the national mint. With the abolition of platinum as a money metal in Russia, the product came into direct competition with that of Colombia, depressing the Colombian trade to a great extent. Since 1894 Russia has supplied 95 per cent of the world's consumption, Colombia furnishing only a part of the remainder. Until very recently the only platinum mining in Colombia has been that of the individual native, who only works under the pressure of want. The total production up to the close of 1907 in Colombia may be estimated at a maximum of 500,000 ounces.

The book of Vicente Bestrepo entitled "Estudio sobre las minas de oro y plata en Colombia," of which a second edition was published in Bogota in 1888, is the chief source of information.

The additional information in this report has been obtained from statements of residents and travelers in the platinum districts and from consular reports.

The two districts in Colombia in which platinum is found are both on the western or Pacific side of the State. The principal of these districts covers the greater part of

the intendencia of Choco and extends over 2 degrees of latitude, namely, from 4° 30′ to 6° 30′ north latitude. The other district known as Barbacoas is the southwest corner of the department of the Cauca, from the frontier of Ecuador, latitude 1° north, along the Pacific coast to Micay River, latitude 3° north. The intermediate country, between 3° and 4° 30′ of north latitude, is not generally recognized as platiniferous, but the metal appears to have been detected there by at least one explorer.

The Colombian Government has lately issued a map of the intendencia of Choco on which a yellow tint indicates the auriferous region, practically covering the whole territory, and a pink shade the part that is also platiniferous—a strip between the upper San Juan and the Tamana rivers. Platinum is found in many of the rivers of the yellow area, but the pink color is meant to denote the locality in which extensive alluvial deposits occur, containing both metals in fairly equal quantities. It is known, however, that there are similar deposits in the Bebara, the Negua, and the Andagueda valleys, so that the map must not be interpreted too strictly. On its margin is a list of the platiniferous rivers.

Of the two principal platiniferous sections, the Barbacoas district, named from its chief town, is a very mountainous country, with abrupt rises from sea level to altitudes of more than 10,000 feet, and its rivers run through some of the deepest valleys in the world. Gold and platinum are found in the beds of the rivers and streams and in the alluvial deposits occuring on the mountain slopes where they are not too steep. The production of gold is so much more important than that of platinum that the latter seldom finds mention in accounts of the district. Not even an approximate estimate of the percentage found with the gold in the placers can be made.

There is no difficulty in reaching the Barbacoas district. The Pacific coasting steamers running between Panama and Guayaquil call regularly at the port of Tumaco, from which the distance to the city of Barbacoas is about 75 miles by steamboat plying twice weekly. A government road is in course of construction from thence to Tuquerres, and other points may be reached by water or by rough bridle paths.

The Colombian Government has granted a concession to an Australian company for dredging Patia River. No mention is made in the document of platinum, nor is the river described in Vicente Bestrepo's book as platiniferous; but some of its tributaries are known to bear that character, as are the placers on its banks. A dredge has lately been built in the river, and the company expects to find much platinum mixed with the gold.

The other and more important platiniferous district, it has already been said, covers a large part of Choco, a territory formerly extending from Cape Tiburon on the Gulf of Darien to the mouth of San Juan River on the Pacific, a length of 320 miles. The greatest width from Cape Corrientes to the sources of the Atrato is 90 miles, but it narrows down at the mouth of the Atrato to 13 miles.

The geology of the platiniferous district of Choco is described at some length by A. Codazzi and by Robert B. White, as quoted by Bestrepo in his book (pp. 70–74). It is sufficient here to say that the principal chain of the Andes is believed to have been elevated at the end of the Cretaceous period. So great was the uplift that beds of marine origin are now found at heights of from 8,000 to 10,000 feet above sea level. The gold and platinum are found in alluvial deposits, more particularly where these are composed of sand and gravel. The deposits occur from 131 to 2,952 feet above sea level. The thickness of the gravels is given as from 300 to 700 feet. The discrepancies in the statements are considerable, showing that no very accurate examinations have yet been made. Numerous streams and torrents, cutting their way through the alluvium, have carried down to the rivers great quantities of sand and gravel with the particles of gold and platinum therein contained; consequently there are two distinct zones, apart from that of the mother rock, in which these precious metals may be found. One of these is the irregular area of alluvium scattered on the mountain slopes at an elevation above sea level not yet accurately determined. The other consists of river beds and the bottoms of the valleys in which the rivers run, and here the operations of the pan washer must be suspended when the rivers are in flood, but dredges might work at all times.

The Atrato and San Juan rivers form the main avenues of approach to Choco. Small steamers run from Cartagena up the Atrato as far as Quibdo, and from Buenaventura up the San Juan to Calima, some 30 miles from the mouth. Quibdo can also be reached by steamer from Barranquilla to Puerto Berrio, thence by train to Providencia, and thence by a long horseback ride by way of Medellin.

Except the trail just mentioned, which has a telegraph line alongside it, the only one in Choco, there are no good highways in the intendencia.

Mr. Granger and others state Choco platinum is probably of average fineness and usually agrees in the size of its grains with the coarseness, or otherwise, of the gold with which it is found deposited, but that the bulk of it is in fine scales and that nuggets are comparatively rare.

It is difficult to make a forecast of the probable future output of platinum from Colombia, not because the country is unexplored and unknown, but because no organized or scientific attempt has yet been made to test the value of the deposits containing this metal. A mining company has now been formed in Bogota for this very purpose, called the Mineral Syndicate of the Condoto. The company has ordered a dredge from the Risdon Iron Works, San Francisco, Cal.

With the expected output from the Patia and the possible productions of the Condoto and other rivers, Colombia may possibly in course of time become a great producer of platinum.

METALLURGY AND USES.

From the report of Dr. W. Geibel, already quoted, the following discussion of the metallurgy and uses of platinum is taken:

METALLURGY.

We have already laid stress upon the fact that the ore is not pure platinum, but is an alloy of six platinum metals. In addition the crude ore contains some gold, that can be separated by amalgamation, then iron, and the other heavy accompanying minerals, chromite and magnetic iron.

The separation is done chemically. In Russia two factories in St. Petersburg do this work. The quantity of ore worked up by them is small, amounting to about 200 kilograms a year, a very small per cent of the total production. By far the larger part is sent abroad. The working up of the ore is almost exclusively in the hands of a few firms in Germany, England, and France. America covers most of her large platinum demand by purchase of the pure metal from Europe, although some crude American platinum is also worked up.

The separation of the platinum metals from the accompanying minerals is quite simple; on the contrary, the exact separation from one another of the individual metals (of the platinum group) which are so similar in their characteristics forms one of the hardest tasks of chemistry. And yet it is frequently important that exact separations should be made, for even small admixtures of other metals may strongly affect the technically important qualities of the entirely pure platinum metal desired; thus a small content of iridium makes platinum considerably harder.

The first task is to separate the most important metal, platinum, from the ore. Then in addition to this is the further task of separating from each other the other five metals; for in the course of time important uses have been found for them all. As they are present in the ore only in small quantities, their value is even greater than that of platinum.

The separation can be made by the dry method by a smelting process and by the wet method by dissolving the ore. The dry method was used in the sixties by Deville and Debray, who did great service for the chemistry of platinum metals and the technics of working them up. As this method does not give a perfect separation, the wet method is now in general favor. The processes employed in this operation generally follow the methods which are used in making an analysis in the laboratory. The details, in which many variations are possible, of course, are the secret of the factories; on the whole, they are as follows: By a treatment with aqua regia the largest part of the precious metal is dissolved; the residue contains, besides sand, the alloy osmium-iridium. Strictly speaking, the ore thus consists not of one alloy, but of two, crude platinum and osmium-iridium. Both contain all six platinum metals, but in different quantities; the crude platinum contains, besides platinum, principally palladium, rhodium, and iridium, together with small quantities of osmium and ruthenium; the osmium-iridium contains, as the name implies, for the most part osmium and iridium, but it contains the other metals also.

It is comparatively easy to separate osmium and ruthenium; they are distinguished by the fact that they are converted by oxidization into volatile oxygen compounds, which can be removed by distillation. With sal ammoniac, platinum and iridium give compounds difficult of solution, from which the metals are obtained by ignition. If the solution of crude platinum in aqua regia acid with sal ammoniac is omitted, then the precipitate contains besides platinum and iridium also considerable quantities of rhodium and palladium, and complicated methods have to be used to obtain the pure metal. On the other hand, the platinum and iridium can not be fully removed in this way, and the mother liquor of the sal ammoniac precipitation contains in consequence considerable palladium and rhodium, and also small quantities of iridium and platinum, and requires complicated working over.

Whatever progress has been made in the attainment of exact methods of separation in recent years is due to the work which Mylius and Foerster have done in the Physikalisch-technische Reichsanstalt.[a] They found by means of the most exact analytical methods that the purest marketable platinum may contain at most 0.01 per cent of impurities.

By igniting ammonioplatinum chloride we get the platinum as a loose gray mass, the so-called "platinum sponge;" from this the compact metal must be produced. The difficulty lies in the fact that platinum melts only at a very high temperature, between 1,700° and 1,800° C. When at the beginning of the nineteenth century the value of platinum for technical uses was discovered, the means of getting such a high temperature were not available. This obstacle was first conquered by melting the platinum with arsenic into an easily fusible alloy, after which the arsenic was roasted out. Later the capacity of the metal for easy welding was utilized. By means of high pressure the sponge was compressed; the cake formed was then ignited and hammered; and in this way the individual particles were welded together.

The temperature necessary for melting platinum is obtained with an oxyhydrogen blowpipe or in an electric oven. With the apparatus available to-day we can melt not only platinum, but also the other platinum metals, which, with the exception of palladium, have still higher melting points.

The further working up of the melted platinum presents no difficulties. It can be hammered and welded, rolled and drawn out to the finest thread; we can give it, therefore, any form desired.

In addition to the pure metal, manifold alloys are prepared and used for numerous purposes.

USES.

The oldest uses of platinum were based on its resistance to chemical action. It remained unchanged in air at any temperature below melting point; it was not noticeably affected by either acids or alkalies, with the single exception of aqua regia, which dissolved it in heat. It was used, therefore, in the equipment of chemical laboratories for crucibles, vessels, spoons, etc.

Platinum found its first technical use in the sulphuric-acid industry. Concentration apparatus was made of it, as other materials were strongly acted upon by the highly concentrated sulphuric acid. The observation that gold is still more resistant, and the discovery of a method of welding gold on platinum, led to the introduction by the firm of Heraeus of the platinum-gold double kettle. As such apparatus often has a weight of 60 to 70 kilograms, it represents considerable capital, and, as has been already mentioned, when the price of platinum rose above that of gold, many firms replaced their platinum apparatus with gold.

As platinum is not oxidized in the air, but remains bright, it is used in the electrical industry for contacts in induction apparatus, electric bells, etc. Pure platinum is not used for this purpose, however, but platinum-iridium alloys, because of their greater hardness.

Within recent years there has been a very considerable increase in the use of platinum in jewelry. Platinum is without doubt the best material for mounting diamonds.

Its resistance to chemicals makes platinum especially suitable as a material for anodes in the electrolytic industry. It is the material best adapted for the preparation of chlorine and alkalies, bleaching lyes, and chlorates; for it is extremely durable and gives the highest yield, as all secondary reactions are lacking. The high cost sets a limit to its use, and for this reason a cheaper material has frequently to be employed.

The high melting point of platinum also makes it valuable for electric heating. The construction of certain electric furnaces put on the market is based on the electric heating of platinum. Platinum wire or platinum foil is embedded in highly fireproof materials. These ovens can be made in various forms; there are electrically heated pipes, muffles, and crucibles. Their availability is limited only by the fact that the known fireproof materials become electrolytically conductors below the melting point of platinum, a property which Nernst utilizes in his well-known lamps. Temperatures above the melting point of platinum can be obtained for scientific purposes by heating an iridium pipe, which is then, of course, not embedded in fire clay. Iridium melts at about 2,300° C.

Another interesting utilization of platinum is the measuring of high temperatures by the use of thermoelectricity. A thermo-element now in use consists of one wire of chemically pure platinum and another of an alloy of 90 per cent platinum with 10 per cent rhodium. In this case the purity of the metal plays an extremely important part.

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[a] Reports of the Deutsche Chemische Gesellschaft, vol. 25, p. 655.

A fourth way of measuring temperature depends on the alteration in the electric conductivity of a metal, resulting from changes of temperature. On this principle rests the resistance thermometer, which is also made of platinum.

Platinum is much used for making the sparking plugs in explosion motors. The compressed mixture of gases is caused to explode by an electric spark generated between the two platinum points.

As the coefficient of expansion of platinum is about equal to that of glass, platinum wire can be melted in that material. The incandescent-light factories make extensive use of it for this reason. The weight of the two wires used amounts to only a few milligrams, but their production in the aggregate places the incandescent-light factories among the principal consumers of platinum.

The consumption of platinum in the manufacture of artificial teeth is even greater. Platinum is used for this purpose because its coefficient of expansion is about equal to that of the tooth structure.

By reduction of the platinum salts solution platinum is obtained as a very finely separated, black powder, the so-called "platinum black." In this state platinum has the property of accelerating chemical reactions among gases without itself being affected. Thus, hydrogen and oxygen, for instance, will not combine at an ordinary temperature; but if the two gases are passed into rather finely divided platinum the latter glows, and the hydrogen and oxygen unite into water. It is owing to this property that the heated platinum point of the pyrographic apparatus is brought to a glow by the inrush of the mixture of benzine and air.

The most important industrial use of platinum catalysis is found in the sulphuric-acid industry. Sulphuric acid is made of sulphuric dioxide, oxygen, and steam: $SO_2+O+H_2O=H_2SO_4$. Now, the SO_2 does not directly unite with O, and use is made in the lead-chamber processes of nitric acid as an oxidizing agent. In the year 1878 Clemens Winkler discovered that the two gases react if they are conducted at high temperature over finely divided platinum. From the discovery of this fact to its practical utilization was a long road, which can not be here followed through all its windings. Suffice it to say that the reaction was finally made industrially available, and to-day more than half of the sulphuric acid is made by the contact process.

The foregoing statement of the uses of platinum is limited to a description of the more important fields of its usefulness. Not only the platinum metals themselves, but also many of their salts, find technical utilization. Thus, barium platino-cyanide is used for making the well-known light shade for the Röntgen apparatus; great quantities of potassium platino-chloride are used in photography for making platinum types, and the ceramic art employs the salts of all platinum metals in making fireproof colors.

Reliable figures on the consumption of platinum in the individual industries are not available. The development of electrical technics entails a steadily growing consumption; the use of platinum for jewelry has increased enormously in recent years, but is dependent on fashion, and therefore may quickly decline. The great revolution in the sulphuric-acid industry makes itself decidedly felt in the platinum business. The quantity of platinum used for artificial teeth is astonishingly large, amounting to about one-third of the total consumption—that is, to about 2,000 kilograms a year. This quantity of platinum is necessarily almost lost to the industry. And the case is the same with the greater part of the platinum used in the electrical industry. It never occurs to anyone to detach the little platinum plates on an old electric bell, because they are worth only a penny or two, and even getting the platinum from old incandescent lights is not very profitable. Only about a third of the metal used for this purpose finds its way back to the melting pot as old platinum; the remainder has always to be supplied new.

CADMIUM.

By C. E. Siebenthal.

INTRODUCTION.

The chief output of cadmium comes from the zinc producing regions of Silesia, where it is recovered in zinc smelting. During the last two years cadmium has been produced in the United States. The zinc ore of the Joplin district averages fully as high in cadmium as the cadmium-bearing zinc ores of Silesia. For this reason, and because of the increasing use of this metal in art and industry, the following short account of the metal is given.

PRODUCTION.

Cadmium has been produced in the United States since 1907 by the Grasselli Chemical Company, of Cleveland, Ohio. The metal is recovered, according to various accounts in the technical journals, as a by-product in the fractional distillation of zinc ores, but of this there has been no official confirmation. Inasmuch as the production is confined to one firm, the quantity and value of the output can not be given. That it does not fall far short of supplying the domestic demand, however, is to be inferred from the sudden fall in the value of cadmium imports for consumption, as given on a later page.

PRODUCTION IN GERMANY.

The following table gives the production of cadmium in Upper Silesia from 1882 to 1908, inclusive:

Quantity and value of cadmium produced in Germany, 1882–1908.[a]

Year.	Quantity.	Value.	Average price per pound.
	Pounds.		
1882	7,762		
1883	5,333		
1884	6,118		
1885	7,222		
1886	10,944	$8,710.56	$0.80
1887	16,140	11,542.29	.72
1888	10,573	5,439.49	.51
1889	11,327	4,641.71	.41
1890	9,167	3,477.18	.38
1891	6,281	2,423.32	.39
1892	7,055	2,713.20	.38
1893	11,651	5,198.87	.45
1894	15,095	8,393.31	.56

[a] Recalculated to pounds and dollars from Statistik des Oberschlesischen Berg-und Hüttenmännischen Vereins, as quoted by Jensch, from Vierteljahreshefte zur Statistik des Deutschen Reichs and from Statistisches Jahrbuch fur den Preussischen Staat.

Quantity and value of cadmium produced in Germany, 1882–1908—Continued.

Year.	Quantity.	Value.	Average price per pound.
	Pounds.		
1895	15,095	$9,052.04	$0.60
1896	23,514	19,453.64	.83
1897	34,231	42,037.23	1.23
1898	32,954	29,666.70	.90
1899	21,693	15,544.26	.72
1900	29,835	19,524.81	.65
1901	28,977	19,754.71	.68
1902	27,833	15,132.00	.54
1903	36,519	19,242.06	.53
1904	55,655	32,882.32	.59
1905	54,163	35,240.18	.65
1906	47,368	36,083.89	.76
1907	72,639	60,757.35	.84
1908	[a] 68,350	.....	.....

[a] Estimated by Paul Speier.

IMPORTS.

Cadmium is imported into the United States as metallic stick cadmium and as the pigment, cadmium sulphide (CdS), cadmium yellow. The former is free of duty, while the latter is dutiable at 30 per cent ad valorem. The value of the imports for consumption of metallic cadmium for 1903 to 1908, inclusive, is given in the table below, which is taken from the records of the Bureau of Statistics. The quantities are not there recorded, and they have accordingly been computed by dividing the values of the imports by the average price of cadmium for the corresponding years in Silesia, from which country the cadmium was imported. The quantity of cadmium imported as a pigment and the value thereof are not kept separately by the Bureau of Statistics.

Cadmium imported for consumption into the United States, 1903–1908, in pounds.

Year.	Quantity (computed).	Value.	Year.	Quantity (computed).	Value.
1903	8,679	$4,565	1906	13,808	$10,522
1904	7,655	4,524	1907	1,953	1,633
1905	8,138	5,298	1908	.....	2,390

RESOURCES.

CADMIUM ORE.

The principal cadmium mineral is the sulphide, greenockite (CdS), but no deposits of this mineral have as yet been discovered which reach such volume as to be called cadmium ore. Deposits of greenockite are known at Bishoptown, Scotland; at Przibram, Bohemia; and at Neu-Sirka, Transylvania.

In the Joplin district crystals of blende occurring in pockets or crevices are often coated with a greenish-yellow deposit of greenockite. This is a secondary deposition or enrichment caused by the decomposition of cadmium-bearing blende in the superficial part of the ore body and the precipitation of the cadmium as sulphide at lower points. In no case known to the writer does this amount to more than a mere coating, which easily rubs off.

CADMIUM-BEARING ZINC ORES.

The chief source of cadmium the world over is cadmiferous zinc ore, sulphide, silicate, or carbonate, as the case may be. Lead ores likewise contain some cadmium, but not so commonly and in less quantity than zinc ore. Cadmium is reported in flue dust from Colorado lead smelters and in dust from lead-ore roasting furnaces at Freiberg, Germany. The oxidized zinc ores, smithsonite and calamine, generally carry a higher percentage of cadmium than does the blende in the same vicinity. Jensch [a] has noted that the works on metallurgy give the cadmium content of Upper Silesia zinc ores as 2 to 5 per cent, and that this refers to the upper, shallower ores which have now been exhausted. He gives a large number of analyses of zinc ores, as mined more recently, of which few show more than three-tenths of 1 per cent of cadmium, and the average of all of which gives 0.102 per cent of cadmium. He also gives analyses of blendes and calamines from other parts of Europe which are being mined at present, and these also rarely contain more than three-tenths of 1 per cent of cadmium.

In South America [b] zinc blende is reported from Morro do Bule, Ouro Preto, Brazil, which contains 2.4 per cent of cadmium, as well as 0.52 per cent of arsenic and 3.89 ounces of silver to the ton. It is found in vein formation in limestone.

In the United States, also, cadmium is found in the zinc ores. The zinc ores of the Eastern States, with the exception of blende from Eaton, N. H., and Friedensville, Pa., have not been reported as cadmium bearing, though doubtless for the most part they carry small quantities of the metal. The ores of the upper Mississippi Valley are comparatively free from cadmium, so far as analyses are available. The zinc ore of the Kentucky-Illinois fluorspar district contains considerable cadmium and secondary deposition of greenockite has been noted as common.[c] In the table of analyses which follows on a later page two analyses are given of blendes from this district, one from Illinois and one from Kentucky, both of which show small percentages of cadmium. No analyses of calamines showing the cadmium content are available from this district.

The Joplin district shows a comparatively large percentage of cadmium, the average of nearly 11,000 shipments, mostly carload lots, as shown in the table below being 0.358 per cent. This table of analyses of blendes from the Joplin district is quoted largely from an article by Prof. W. George Waring. Two additional analyses of composite samples made by the same authority in 1904 are also included.

On the assumption that Joplin blende contains an average of 0.358 per cent of cadmium, as indicated by the table, the total cadmium content of the 236,860 short tons of zinc blende produced in the Joplin region in 1908 must have amounted to about 1,700,000 pounds of cadmium, over twenty times the production or consumption of cadmium in the world in 1908. About 85 per cent of the cadmium content of the ore is lost in the roasting and the fractional distillation. Nevertheless, the Joplin district could furnish annually three

[a] Sammlung chem. und chem.-tech. Vorträge, vol. 3, 1898, p. 202.
[b] Annaes da Escola de Minas de Ouro Preto, 1906, No. 8, pp. 17–22.
[c] Ulrich, E. O., and Smith, W. S. Tangier, The lead, zinc, and fluorspar deposits of western Kentucky: Prof. Paper U. S. Geol. Survey No. 36, 1905, p. 36.

or four times as much cadmium as the world consumes. It is evident that the demand for cadmium would have to be largely increased to absorb the cadmium from this district provided it were recovered. Such an increase could only come about by a great reduction in price, possibly necessitating a reduction below the point of profitable recovery of cadmium.

"The following analyses were made with the utmost care, using 5 to 10 grams of ore for the determination of the metals other than zinc, and are representative. They were not made in the ordinary course of commercial work, but especially to accompany this paper."[a]

Analyses of zinc blendes.

[W. George Waring, analyst.]

Ore.	Zinc.	Iron.	Lead.	Copper.	Cadmium.
Sphinx mine, Neck City, Mo	65.77	0.55	0.00	0.077	0.135
Ore from Golconda, Ill	60.55	1.18	.51	.046	.110
Standard mine, Fortuna, Mo	61.97	.55	.815	.133	.436
Maude B. mine, Webb City, Mo	55.70	4.90	Trace.	Trace.	.227
Big Six mine, Aurora, Mo	56.75	1.88	None.	.004	.018
McKinley mine, Prosperity, Mo	57.20	1.25	5.29	None.	.550
Hudson mine, Pleasant Valley, Mo	62.05	.61	None.	.030	.322
Big Circle mine, Oronogo, Mo	56.90	1.64	1.51	Trace.	.110
Willard mine, Mo	63.30	.80	.41	.064	.320
Gundling & Standard, Fortuna, Mo	63.50	.90	.32	.107	.530
October mine, Webb City, Mo	58.10	2.74	.59	None.	.460
Majestic mine, Webb City, Mo	57.05	1.82	1.61	None.	.330
Three Shafts mine, Carterville, Mo	60.20	2.08	.89	.090	.140
Uncle Sam mine, Aurora, Mo	61.20	.75	None.	.010	.590
Underwriters mine, Webb City, Mo	57.95	1.60	1.62	.....	.710
Jack Rose mine, Joplin, Mo	54.70	1.36	1.02	.....	.260
Blende from Kentucky fluorspar mines	53.50	.77	.76	None.	.211
Average of 2,270 carloads from Webb City, Mo., 1902	57.08	2.60	.90	.050	.337
Average of 2,145 shipments, Joplin district, 1903	57.75	2.32	1.07	.042	.388
Average of 2,691 shipments, Webb City district, 1904	58.46	1.97	.720	.050	.430
Average of 3,800 shipments, Joplin district, 1904	58.26	2.23	.701	.049	.304
Average percentage of cadmium in 10,906 shipments, mostly carload lots	.....	.....	.....	.....	.358

Several analyses of zinc ores from northern Arkansas as reported by Branner[b] show a considerable cadmium content. The oxidized ores show notably larger percentages of cadmium than the blende. The following table gives the various available analyses of such ores of north Arkansas:

Cadmium in cadmium-bearing zinc ores of north Arkansas.

	Per cent.
Smithsonite from Wood's mine	0.43
Smithsonite ("turkey fat") Morning Star mine	.79
Smithsonite ("turkey fat") Morning Star mine	.72
Blende from Panther Creek mine	.26

The zinc ores mined in the Western States are known in some instances to carry cadmium. The calamine ores in the vicinity of Hanover, N. Mex., contain sufficient cadmium to give a strong yellow tint to the zinc oxide made from them. Since the Joplin blende, with its average of nearly four-tenths of 1 per cent of cadmium, does not

[a] Waring, W. George, The volumetric determination of Zinc: Jour. Am. Chem. Soc., vol. 26, No. 1, 1904, p. 16.

[b] Branner, John C., The zinc and lead region of North Arkansas: Ann. Rept. Geol. Survey Arkansas for 1892, vol. 5, Little Rock, 1900, pp. 112, 165, 197, 198, 264.

so affect zinc oxide made therefrom, it stands to reason that the New Mexico ore has a considerably higher content of cadmium than that percentage. No assays are at hand showing whether the zinc ores of Colorado, Utah, Idaho, and Montana contain any cadmium.

CADMIUM-BEARING MINE WATERS.

The mine waters in the Joplin region, especially in the districts where mining has been carried on longest, are strongly acid, containing sulphuric acid, zinc sulphate, and smaller quantities of cadmium sulphate. The latter is easily recovered by precipitation as the sulphide after the Waring process, described in "Mineral Resources for 1907," Part I, page 667.

CADMIUM RECOVERED IN REFINING PROCESSES.

Although not exactly resources in the same sense as ore, yet the possible recovery of cadmium as a by-product in certain refining operations justifies their mention at this point as sources of cadmium. Among these operations are the purification of the zinc liquor used in the manufacture of lithopone, the electrolytic refining of cadmium-bearing lead by the Betts process, and the refining of spelter, zinc drosses, and scrap zinc electrolytically or by redistillation.

METALLURGY.

The method used in the recovery of cadmium is in most cases determined by the metal with which the cadmium is associated, which metal is usually zinc, though in some cases cadmium is found with lead. Practically all the cadmium which has been produced in recent decades has been by fractional distillation of cadmium-bearing zinc ores.

DISTILLATION.

The property of cadmium which allows it to be separated from zinc in distillation is that cadmium is both reduced from the oxide to the metallic form and is volatilized at a considerably lower temperature than zinc. As the charge of cadmium-bearing zinc ore and carbon is heated up in the retort, therefore, the cadmium is reduced and vaporized and passes over into the condenser first. The passage of cadmium vapor is shown by the brown color of the flame which escapes from the openings in the retort. After about two hours, or as soon as the flame turns white, showing the passage of zinc vapors only, the condenser is removed and another substituted to catch the zinc. The cadmium zinc dust caught during these first two hours may contain as much as 5 to 8 per cent of cadmium. This dust is usually enriched to 50 per cent of cadmium by one or more redistillations and is finally distilled in small clay retorts or in cast-iron retorts with long sheet-iron condensers. In the clay retorts the metallic cadmium collects in the lower fore end and is drawn off through a tap hole into molds. The cadmium which collects in the condenser of the iron retort is transferred to a ladle, covered with a layer of oxidized material from the retorts and with a layer of tallow, then melted, and cast in rods. The loss of cadmium in these processes is very great, amounting to 65 or 75 per cent,

which, taken in conjunction with a loss of something like 60 per cent in calcining the ores, makes a total loss of 80 to 90 per cent of the original cadmium content of the sulphide ores. The foregoing comprises the general procedure in the recovery of cadmium as practiced in Upper Silesia, where most of the world's supply of cadmium is obtained. Various modifications of the general method need not be here discussed.

ROASTING AND LEACHING.

Mendeléeff says:[a] "When zinc blende containing cadmium is roasted the zinc passes into the state of oxide, and the cadmium in the ore oxidizes into cadmium sulphate, $CdSO_4$, which fairly well resists the action of heat; therefore if roasted blende be washed with water a solution of cadmium sulphate will be obtained, from which it is very easy to prepare metallic cadmium."

As this observation seemed to offer some chance of a commercial method of obtaining cadmium, a few tests bearing on the point were made in the chemical laboratory of the United States Geological Survey by Dr. Chase Palmer. Samples of roasted concentrates (zinc oxide) were obtained from three smelters which are using Joplin blende exclusively. Of each sample, 1,000 grams was digested with frequent shaking in 1,000 cubic centimeters of warm distilled water. After twelve hours the liquid was decanted and 500 cubic centimeters of fresh water was poured on the ore. After another twelve hours the water was again decanted and the ore was again leached for twelve hours with 500 cubic centimeters of water. The mixed filtered solutions were then evaporated to small volume, and the cadmium was precipitated as sulphide, converted into the sulphate, and weighed. The results are given in the following table:

Results of leaching roasted Joplin zinc blende concentrates.

	1.	2.	3.
Quantity of roasted ore taken.....grams..	1,000	1,000	1,000
Probable cadmium content per 1,000 grams of raw blende, assuming average as given in preceding table of analyses.....grams..	3.580	3.580	3.580
Probable cadmium content per 1,000 grams of roasted blende, calculated from above.....grams..	4.286	4.286	4.286
Determined cadmium content of roasted blende samples.....do....	1.700	2.700	2.000
Cadmium recovered, as sulphate, by leaching.....do....	.437	.836	.836
Percentage of cadmium recovered from roasted ore by leaching.....	0.044	0.084	0.084

Stated in pounds per ton of ore the foregoing table means that each ton of Joplin blende probably contains 7.16 pounds of cadmium. The roasted concentrates, provided no cadmium has been volatilized, should contain about 8.57 pounds of that metal. By no means, however, is all of the cadmium recoverable as the leached sulphate. Some of it may be volatilized as the oxide and some as the sulphate. Jensch has shown that 40 per cent of the cadmium found in the flue dust from the roasting furnaces is the soluble sulphate. Another portion may be changed to oxide and remain behind with the zinc oxide,

[a] The principles of chemistry, 1st English edition, trans. from 5th Russian edition, New York, 1891, vol. 2, pp. 44–45.

if the temperature of the furnace be too high, and the oxide, being insoluble in water is not recoverable by leaching. As may be seen from the table, only one-third to one-half of the probable cadmium content was actually present in the roasted concentrates; and of the cadmium present only one-fourth to two-fifths was recovered by leaching. This shows that probably one-half or more of the cadmium is volatilized in the roasting furnaces and that three-fifths or more of what remains has been changed to the oxide. All of which suggests that the temperature of the blende-roasting furnaces in ordinary practice is maintained at too high a point for the successful operation of the process under consideration. Careful experiment would probably determine a temperature at which the cadmium would be converted to the sulphate with reasonable completeness and thus become recoverable by leaching. From the sulphate the cadmium may be precipitated as metal by metallic zinc and refined by electrolysis or may be precipitated as the sulphide by hydrogen sulphide and be reduced to metallic cadmium by oxidation and distillation with carbon. In plants where the sulphur fumes from the roasting furnace are utilized in making sulphuric acid, a cheap source of hydrogen sulphide would be found in the treatment of zinc blende with sulphuric acid, yielding hydrogen sulphide with zinc sulphate as a commercial by-product. The process could possibly be economically worked by mechanically receiving the continuous hot discharge of the roasting furnace, leaching the concentrates, recovering the cadmium, drying the leached concentrates, and delivering them to the mixing floor for zinc distillation.

It is likely that the greater part of the cadmium will continue to be recovered by fractional distillation. In the not unlikely event, however, that retort zinc smelting shall be displaced by electro-thermic smelting or smelting in continuous furnaces, fractional distillation will not be profitable as a method for the recovery of cadmium. At such time the sulphatizing roast and leaching method will be available.

Philip A. Mackay was granted a patent in 1905 (U. S. patent No. 799,743) on a process of subjecting cadmium-bearing zinc concentrates to a "dead roast," by which the cadmium sulphide is converted to the sulphate and may be removed by washing with water. The advantages claimed are cadmium-free spelter and cadmium-free zinc concentrates for the production of zinc-oxide pigment. As shown on a preceding page, the essential feature of this patent had prior publication by Mendeléeff.

Stahl [a] proposed to convert zinc ores to chloride by a chloridizing roast, to leach the chloridized mass, and to precipitate the other metals by scrap zinc from the liquor obtained by leaching, the liquor to be treated for zinc as desired. The spongy mass of metals precipitated by the zinc scrap would contain cadmium, lead, and other metals. These could be separated by distillation or by electrolysis. This process could apparently be worked to recover cadmium in connection with the production of zinc chlorides directly from ore by chlorination processes.

[a] Schnabel, C., Handbook of metallurgy, vol. 2, p. 50.

ELECTROLYTIC RECOVERY.

For the reason that the method of recovery of cadmium is determined by the method used in the reduction of the associated zinc, and since zinc, as is shown in the chapter on zinc in this volume, is recovered electrolytically by but one company, it follows that little but experimental work has been done in the recovery of cadmium by that method.

Mylius and Fromm [a] extracted cadmium under the same conditions as zinc and with much less trouble. The solution must be kept in motion to prevent the formation of a spongy deposit. Brand [b] successfully refined impure cadmium by electrolysis, using a solution of cadmium sulphate. Senn [c] proved by experiment that cadmium can be refined under the same conditions as lead, using the fluosilicate solution as in the Betts process.

CHEMICAL METHODS OF RECOVERING CADMIUM.

According to Speier [d] the solution of zinc sulphate used in the manufacture of lithopone is purified by precipitating with metallic zinc the extraneous metals in solution, which gives slimes containing as much as 30 to 70 per cent of metallic cadmium. These slimes are compacted into masses which serve as anodes for the electrolytic recovery of the cadmium. This process has been in operation in England for the last three years.

Kossmann [e] proposed to treat blende-roasting furnace flue dust, which contains some soluble cadmium sulphate and some insoluble cadmium oxide, first with water, then with sulphuric acid, thus bringing all the cadmium into solution as the sulphate, and then, after dilution, precipitating the cadmium with hydrogen sulphide.

USES OF CADMIUM.

Cadmium is used in metallic form in amalgams and alloys, and the various salts of cadmium are used in the arts, in medicine, and in electroplating.

ALLOYS.

Cadmium, like bismuth, lowers the melting point of alloys into which it enters, but while bismuth forms brittle alloys, cadmium usually makes them more ductile or malleable, though in some cases, as for instance with gold, platinum, and copper, the contrary is true. Cadmium is objected to in spelter, for instance, on the score that it makes brittle brass, not suitable for the finest work, such as cartridge shells, etc. A private communication from a maufacturing firm requiring the highest grade of brass is as follows:

> Tradition among brass workers is to the effect that cadmium is extremely deleterious, and that small quantities—as small as three one-thousandths to four one-thousandths of 1 per cent—seriously detract from the value of brass for purposes of drawing.
>
> A meager record kept some years ago does not go to confirm entirely the tradition in regard to cadmium—that is, we were able, although with some slight difficulty, to make use in brass of lead-free spelter, to which we added quantities of cadmium to the extent of five-tenths to seventy-five one-hundredths of 1 per cent; so under the circumstances we can quite definitely say that, relatively, cadmium is not as serious a

[a] Zeitschr. anorg. Chemie, 1898, 13, 157.
[b] Schnabel, C., Handbook of metallurgy, vol. 2, p. 328.
[c] Zeitschr. Elektrochemie, vol. 2, 1905, pp. 229–245.
[d] The Mining Journal (London), November 9, 1907, p. 573.
[e] Schnabel, C., Handbook of metallurgy, vol. 2, p. 327.

detriment to brass as lead. On the other hand, there is no doubt that lead, cadmium, and arsenic, in the order given, have a tendency to make brass brittle and to prevent its drawing properly.

Ingalls, after inquiry among brass makers, concluded that the cadmium content of American spelter, as it had not encountered trade objection, was not such as to be greatly deleterious in brass making. He quotes the investigations of a German chemist to the effect that 0.25 per cent of cadmium in spelter is no drawback, but that cadmium in excess of 0.5 per cent has an unfavorable effect. American brands of spelter rarely contain so much as five-tenths of 1 per cent of cadmium.

The ordinary dental amalgam consists of 26 per cent of cadmium and 74 per cent of mercury. Tin or bismuth is frequently added to render the amalgam more pliant under heat.

Cliché metal, for stereotype plates, consisting of 50 per cent lead, 27.5 per cent tin, and 22.5 per cent cadmium, is better than the corresponding cliché alloy of bismuth, since it melts at as low a temperature, is harder, and gives a greater number of impressions.

Fusible alloys, of a number of which the composition and melting point are given in the following table, find use as soft solders for soldering tin, lead, etc., as electric fuses, as fusible plugs for automatic fire sprinklers, etc.

Cadmium alloys.

[Parts by weight.]

	Cadmium.	Lead.	Tin.	Bismuth.	Melting point (° F.).
Lipowitz's metal	3	8	4	15	158
Wood's metal	2	4	2	5	140–160
Fusible alloy	2	11	3	16	170
Do	10	8	3	8	167
Do	1	.....	2	3	203
Do	1	.....	3	5	203
Do	1	.....	1	2	203
Do	1	2	1	4	150
Do	2	2	4	.....	187
Electrical cut-off	15	20	21	50	.....

Lipowitz's metal has a silvery-white color and a luster like polished silver, and it can be bent short, hammered, and worked in the lathe. It is used for making casts of small animals and insects, and is a suitable solder for tin, lead, and especially for Brittania metal.

Wood's metal resembles platinum in color and is malleable to a certain extent.

SALTS OF CADMIUM.

The principal uses of the salts of cadmium, as taken from Merck's 1907 Index, are as follows:

Dentistry: Cadmium acetate.

Dyeing and calico printing: Cadmium chloride.

Glass making: Cadmium nitrate gives the reddish-yellow cadmium luster to glass and to porcelain glazes.

Photography: Cadmium chloride, cadmium iodide, and hydrated cadmium bromide.

Pyrotechnics: Cadmium sulphide.

Mineral separation by liquids of high specific gravity: Cadmium borotungstate solution, Klein's reagent, has a specific gravity of 3.28 and is used in the laboratory to separate minerals heavier than 3.28 sp. gr. from minerals lighter than 3.28 sp. gr.

All cadmium salts soluble in water and in dilute acids are poisonous.

ELECTROPLATING.

Cadmium may easily be electro-deposited upon metallic surfaces. Smee was one of the first to deposit cadmium electrolytically, using a solution of "ammonio-sulphate" of cadmium with a cadmium anode. In the Russell and Woolrich process, patented in 1849, a solution of cadmium cyanide was used with a cadmium anode. Cowper-Coles used the double cyanide of cadmium and potassium with metallic cadmium for the anode. Bertrand recommends a solution of the bromide with a little sulphuric acid, or a solution of cadmium sulphate. Patten and Mott secured smooth deposits of cadmium at low-current densities from a solution of cadmium chloride in acetone.[a]

The cadmium deposit though soft, is harder than silver, and the color is as white as tin, though not as white as silver. The surface, which takes a very high polish, is not readily tarnished by sulphureted hydrogen or other vapors.

Alloys of cadmium with a small percentage of silver are used instead of nickel for plating steel, as they afford much better protection to the steel than nickel and resist tarnishing better than either pure silver or standard silver. Cadmium-silver alloys are used to a considerable extent also in silver plating. The quantity of cadmium employed may reach as high as 25 per cent without affecting the color or appearance of the plate. It is said that most American manufacturers use an alloy containing 5 per cent of cadmium.

CADMIUM YELLOW PIGMENT.

Cadmium sulphide (CdS), is the pigment cadmium yellow (jaune brillant). Properly prepared it is one of the most permanent pigments known and is unaffected by exposure to light and air; it is not affected by hydrogen sulphide gas from coal smoke, whereas the common yellow pigments (lead chromes) are blackened in a smoky atmosphere. Considerable imitation Naples yellow is made by mixing cadmium yellow with zinc oxide. Cadmium yellow mixed with ultramarine gives a green pigment.

Cadmium yellow is prepared by precipitation with hydrogen sulphide from an acid solution of a cadmium salt. The precipitate is bright citron yellow from weakly acid solution and orange yellow from strongly acid solution, and these two shades of cadmium yellow are on the market. The citron-yellow pigment is the one commonly ground in oil for the use of artists. It is not adapted for use with ordinary paint vehicles, owing to the more or less general use in them of lead, which becomes discolored rapidly. The orange-yellow pigment is the one in more general use.

A single coat of cadmium yellow paint is more or less transparent, and as the pigment is quite expensive it is customary to use a coat of cadmium yellow over several coats of chrome yellow, the former serving as a protective coating for the body of the latter pigment. This plan is followed by certain railway and street-car companies which finish their passenger coaches in yellow. Chrome yellow alone for such uses is apt to fade under the action of light and to darken under the action of sulphur gases. The particular advantage

[a] Patten, H. E., and Mott, W. R., Electro-deposition of some metals from acetone solution: Trans. Am. Electrochem. Soc., vol. 15, 1909, pp. 529–532.

of the chrome yellow for ordinary purposes is that it can be worked in any shade from lightest canary to deepest orange. On the whole, the cadmium yellow and the chrome yellow seems each to have its particular advantages, and it is not apparent that the use of the former would become much more general even if the price became much cheaper. The market price of cadmium yellow varies from $1.75 to $2.25 per pound; the price of chrome yellow is from 12½ to 26 cents per pound.

Cadmium yellow is also used to a certain extent in the manufacture of rubber goods and in tinting toilet soaps.

STANDARDIZATION.

For measuring electromotive force the normal Weston cadmium cell is found to be the best.

For comparing standards of length the most useful unit is a definite wave length of homogeneous light corresponding to a single spectrum line isolated from the spectrum of cadmium, hydrogen, or mercury. The spectrum of cadmium is well adapted for such use. Thus defined, the standard meter is a piece of metal whose length at 0° C., equals 1,553,164 times the wave length of the red line of the spectrum of cadmium when the latter is observed in dry air at the temperature of 15° C. of the normal hydrogen scale at a pressure of 760 mm. of mercury at 0° C.

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